Cognitive Style: the reliability and validity of verbal-imagery and wholistic-analytic cognitive style

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Thesis Submitted for the degree of PhD in Psychology

THE UNIVERSITY OF EDINBURGH

September 2002

For my parents
who have provided me with every possible opportunity,
given me never ending support and always, always believed in me.
Thank you for everything.

Declaration

(a) This thesis was composed by Elizabeth R. Peterson.

(b) The studies presented in this thesis were all performed, analysed and written by myself.

(c) I hold the degrees of BA in Psychology, BSc in Physiology, BSc Hons in Psychology (all from the Victoria University of Wellington, New Zealand) and MSc by Research in Psychology (University of Edinburgh, Scotland).

(d) This thesis has not been submitted for any other degree, diploma or professional qualification.

27/09/02

Elizabeth Ruth Peterson Date:

Acknowledgements

I would especially like to thank Professor Ian Deary, my supervisor, for his tireless advice, constructive comments and support which were invaluable. I consider myself very fortunate to have had the chance to work with such a wonderful mentor, researcher and academic. I am also grateful for the advice and comments provided throughout by my second supervisor Dr. Elizabeth Austin. I would also like to thank Kevin for his love and encouragement, his analytical eye and for making a genuine effort to understand and contribute to my research life. I would also like to thank Fiona for her solid friendship and words of encouragement throughout and Ian for his patience, reassuring words and computer expertise. Thanks must also be given to the New Zealand Foundation for Research Science and Technology, The Social Science Faculty of Edinburgh University, the Overseas Research Scheme, W D S Stewart Bequest and my parents, for their financial support over the past three years. Finally, I would like to thank all the people that took part and assisted with these investigations, without whom this project would have been impossible.

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ABSTRACT OF THESIS

(Regulation 3.9.14)

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Degree: PhD

Title of Thesis: Cognitive Style: The reliability and validity of verbal-imagery and wholistic-analytic cognitive style.

No. of words in the main text of Thesis: *60,000*

Cognitive styles are defined as an individual's preferred or habitual way of processing information. In this thesis, existing measures of cognitive style are reviewed and the development of a new more reliable and valid cognitive style measure is outlined. The research described in this thesis includes (i) an introduction to cognitive styles research, (ii) an evaluation of Riding's (1991; 1998) popular Cognitive Style Analysis (CSA) test, (iii) the design and pilot of an inspection-time test of wholistic-analytic style, iv) the development of two new reliable tests of verbal-imagery and wholistic-analytic cognitive style (VICS test, and Extended WA test) and (v) the validity of the new tests and their potential impact on theory and practice.

Many different cognitive style measures have been proposed. The most popular computerised cognitive style test in the UK is Riding's Cognitive Style Analysis (CSA) test. The CSA assesses style on two broad dimensions: verbal-imagery (VI) and wholistic-analytic (WA). This thesis examines the test re-test, parallel form and split-half reliability of the CSA's VI and WA dimensions in 50 participants. The results showed that the CSA's crucial style ratios, which are used to determine a person's cognitive style, were not reliable (r = .20 on the VI dimension, and r = .30 on the WA dimension).

To try to improve the CSA's test of the wholistic-analytic dimension, an inspection time test of the WA dimension was designed and piloted. The inspection time WA ratio was found to be moderately reliable over time (r = .595). This line of investigation was put on hold, with the discovery that extending the length of the WA tests increased the split-half reliability of the Extended WA test ratio (mean r = .67). The split-half reliability of the Extended VI test ratio did not improve (mean r = .36). These findings suggested the need to revise the CSA's test of the VI dimension. Therefore, a new computerised test of verbal-imagery cognitive style (VICS test) was designed and tested. The crucial verbal-imagery ratios from the new VICS test were found to have test re-test reliability in 50 subjects of r = .66, and a split-half reliability of r = .72, whereas the reliability of the VI ratios from CSA remained low (r = .32).

Finally, the validity of the new Extended WA and VICS tests was examined in 100 participants; specifically, the relationship that the VICS and the Extended WA had with personality (measured with IPIP, EPQ-R, IVE), intelligence (measured by 8 tests from the Kit of Factor Referenced Cognitive Tests) learning style (measured by ASSIST, PEPS) and behaviour (measured by the Instructional Preference Questionnaire and observed behaviour). No personality trait, cognitive ability, learning style or behaviour measure correlated more than .33 with cognitive style. It is suggested that cognitive style, as measured by the Extended WA test and the VICS test, is independent from personality, ability and 2 other learning style measures. The potential impact of these tests on current theory and practice is discussed.

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Winnie the Pooh talking to Rabbit

"'Well,' said Pooh, 'we keep looking for Home and not finding it, so I thought if we look for this Pit, we'd be sure not to find it, which would be a Good Thing, because then we might find something that we weren't looking for, which might be just what we were looking for really.'
'I don't see much sense in that,' said Rabbit.
'No,' said Pooh humbly, 'there isn't. But there was going to be when I began it. It's just that something happened to it along the way.'"

A.A. Milne (1991, p.268).

Chapter 1

An Introduction to Cognitive Style

> "Every man is in certain respects (a) like other men (b) like some other men and (c) like no other man."
>
> Kluckhohn, Murray and Schneider, 1953, p.53.

1.1 The Historical Background of Cognitive Styles

The word 'style' is associated with concepts as diverse as fashion through to behaviours such as likes and dislikes, how we talk, cope, learn, teach and think. This thesis will investigate style in terms of a psychological phenomenon and in particular, a cognitive phenomenon.

Psychologists' interest in style research largely grew out of investigations into individual differences. In particular, researchers began to wonder whether there were underlying processes that were generating individual differences in ability and intelligence (Grigorenko & Sternberg, 1995). The majority of the initial research focused on investigating individual differences in imagery and perception. For example, Galton (1883) investigated individual differences in tendencies to use imagery strategies as opposed to verbal strategies at recall, and Witkin, Dyk, Faterson, Goodenough and Karp (1962), drawing largely on the Gestalt ideas, focused on individual differences in perceptual ability, especially the ability to separate a figure from the background. More recent research has tended to focus on the role of individual differences in educational settings and the implications of these differences for the learner (e.g., Lovell, 1984; Entwistle, 1988; Tennant, 1988, Riding & Rayner, 1998).

The diverse range of approaches taken to individual difference research is also reflected in the myriad different approaches that have been taken to style research. This has led to a profusion of style concepts and instruments, with many researchers oblivious to the fact that other researchers have devised similar style dimensions disguised under different names. This observation is not new. In 1976 Lewis noted that, in styles research "we have a situation in which different groups of researchers seem determined to pursue their own pet distinctions in cheerful disregard of one another" (p. 305).

1.2 Problems with Styles

According to Curry (1990a), the range of researchers working on styles has led to three main problems. Firstly, there are considerable differences in the concepts, labels and definitions of styles. Secondly, there is disagreement over the relevance of styles, especially the relevance to learners in educational settings. Thirdly, there is confusion over the objectivity, reliability and validity of style measures.

1.2.1 Concepts, labels and definitions of styles

The terms 'learning styles', 'cognitive styles', 'learning strategies' and 'learning skills' are frequently bandied around by style and learning researchers and often used with little consistency in their meaning (Adey, Fairbrother, William, Johnson & Jones, 1999). In particular, the terms 'cognitive style' and 'learning style' are often used interchangeably by researchers, creating considerable confusion in the literature (Furnham, 1995).

The term 'cognitive style' was first used by Allport in 1937. Allport defined cognitive style as a person's innate, habitual or preferred mode of information processing. Adding to this definition Messick (1976) defined cognitive styles as "representing consistencies in the manner or form of cognition, as distinct from the content of cognition or the level of skill displayed in the cognitive performance" (p.5). Riding and Cheema (1991) also point out that cognitive styles are typically measured on a bipolar dimension and contain relatively few dimensions.

The term 'learning style' was adopted when style researchers became interested in the educational and work place applications of style (e.g., Dunn, Dunn & Price, 1979; Honey & Mumford, 1986). Furthermore, Riding and Cheema (1991) note that learning styles are often measured on a unipolar scale, where the individual either has, or does not have, the element in their style and they often consist of multiple elements. A recent citation analysis of the learning and cognitive style literature by Desmedt and Valcke (2002) suggests that research based on authors working in both cognitive and learning styles areas (such as Kolb and Entwistle), resulted in the terms becoming used synonymously. Furthermore, Desmedt and Vackle's analysis shows that cognitive styles historically make up the larger field, being more abstract and less formulated than learning styles.

Despite these distinctions between cognitive and learning styles, Riding and Cheema (1991) argue that since the 1970s the term 'learning style' has become the umbrella term taking into account cognitive style as well as more behavioural factors such as instructional and environmental preferences. Reflecting this change, the 1982 National Association of Secondary School Principals (NASSAP) task force on cognitive and learning styles defined learning style as

> "The composite of characteristic cognitive, affective and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with and responds to the learning environment."
> (Keefe & Ferrell, 1990. p.59).

This current trend of adopting learning styles as the umbrella term is historically and theoretically misleading and no doubt adds to the confusion in definitions.

To further understand what cognitive styles are, it is useful to also distinguish them from cognitive ability, learning strategies and learning skills. A summary of the major differences between these concepts is given in Table 1.1.

The extent to which cognitive abilities differ from cognitive styles has been debated (Furnham, 1995) and several attempts have been made to distinguish between the two (e.g., Kogan, 1973; Messick, 1984; Tiedemann, 1989). Today it is commonly accepted that cognitive style is a measure of the tendency towards a typical performance, with particular emphasis on the most preferred mode of processing (Messick, 1984; Tiedemann, 1989). Cognitive styles are usually bipolar, with each pole having different effects on cognitive processing (Messick, 1984). Relatively little value is placed on having one particular style, although there may be adaptive value for a particular style, depending on the situation (Furnham, 1995). In addition, cognitive styles are not specific to a particular area; instead, they are higher level heuristics, which work across all domains helping to organise and control information processing (Messick, 1984). An example of a cognitive style dimension is the verbal-imagery dimension (Riding & Cheema, 1991). Verbalisers are people who

Table 1.1

Summary table of the key differences between cognitive style, cognitive ability, learning strategies and cognitive skill taken from the work of Adey et al. (1999), Tiedemann (1989), and Messick, (1984).

Cognitive Style	Cognitive Ability	Learning Strategies	Cognitive Skill
Questions the manner or mode of processing	Questions what is processed	General skills used to help processing	Specific skills used to help processing
Measures typical performance use	Measures maximal ability	Measure of general strategy use	Measure of specific strategy
Measured on a bipolar scale (two different poles)	Measured on a unipolar scale (from 0 upward)	Measured on unipolar scale (from 0 upward)	Measured on unipolar scale (from 0 upward)
Value differentiated	Value directional	Value directional	Value directional
Cannot be learned	Can be learned	Can be learned	Can be learned
Cuts across domains	Domain specific	Cuts across domains	Domain specific
Functions as an organising variable	Functions as an enabling variable	Functions as an enabling variable	Functions as an enabling variable
Examples, wholistic or analytic Style	Examples, verbal ability, spatial ability	Examples, mind mapping, goal setting.	Examples, making acrostics reciting times tables

prefer to represent information verbally, and imagers are people who prefer to represent information using pictures or images. That is not to say imagers cannot process information verbally, it is simply more natural or easier for them to process information using imagery. Adey et al., (1999) liken the concept of style to the way people fold their arms. Most people can fold their arms in two different ways, but one particular way feels more natural, whereas the other requires more deliberate thought.

In contrast to cognitive styles, Messick (1984) argues that cognitive abilities refer to the content of information that is processed, by what operation it is processed and by what form. Cognitive abilities have the potential to result in maximum performance with the emphasis placed on accuracy. In this sense, cognitive abilities are unipolar and value laden because the degree of ability can range from zero to a maximum value, with more ability perceived as more advantageous than less ability. In addition, abilities are argued to be domain specific, such as having particularly good verbal or spatial skills. Consequentially, cognitive abilities are perceived as enabling variables as they help to facilitate performance (Messick, 1984).

Two other terms that are frequently used in style research are learning skills and learning strategies. Learning skills are almost the antitheses of cognitive styles in that they are specific 'tricks' which can be taught to aid learning (Adey et al., 1999). For example, "Richard of York Gave Battle In Vain" can be used to remember the colours of the rainbow (red, orange, yellow, green, blue, indigo and violet). Another example of a skill is continuously reciting specific text, such as multiplication tables, until they are learned.

Learning strategies fall in between cognitive styles and learning skills. Learning strategies are "groups of skills that a learner uses together for a particular purpose" (Adey et al., 1999). Furthermore, learning strategies are variable, 'soft-wired' and can be learned. Examples include setting goals, formulating questions and drawing mind maps (Adey et al., 1999). Unlike cognitive styles, learning strategies are unipolar ranging from zero to a maximum value. Therefore, having a particular learning strategy is seen as an asset or ability. In many ways, learning strategies are similar to cognitive abilities, the difference is that learning strategies refer to learning techniques used across domains to assist learning, as opposed to a general skill in a specific domain, which is a cognitive ability.

The differences between learning styles, cognitive styles, learning strategies and learning skills have been conceptualised as a hierarchy, a continuum and as the layers of an onion (Adey, et al., 1999). The underlying concept in all of them is similar. Most have an all-pervasive, innate cognitive type style at one end and specific, teachable and changeable skills at the other (e.g., Curry, 1983; Adey et al., 1999).

1.2.2 Relevance of styles

The relevance and value of styles is another area of style research beset with dispute. Some researchers, such as Riding and Rayner (1998), believe that style is an "under-developed aspect of teaching and learning which may be the key to greatly enhancing levels of individual performance" (p. 47). In contrast, researchers such as Tiedemann (1989) and Furnham (1995) have claimed that cognitive styles are an illusion; they are merely aspects of our behaviour which are of little empirical relevance or significance.

Traditionally, education systems have adapted to individual differences by classifying and grouping people according to their academic ability, rather than adjusting the instruction to the different processes of learning (Messick, 1976). More recently, educational institutions have begun to investigate whether knowledge of individuals' cognitive or learning styles can improve the short and long-term results of teaching and learning and assist with areas of curriculum design, instructional methods, assessment methods and student guidance (Riding & Rayner, 1998). However as Messick notes, the issue is further complicated with debate not only over whether to match style, but also "how to match educational treatments to individuals, who it benefits and who should decide among the alternatives" (p. vii).

In general, it seems that the importance and relevance of style depends largely on whether people think it exists. If style does not exist and it is just a manifestation of other factors, then we should not devote time and resources into researching and developing it. But if style does exist, the question is how can we utilise this knowledge to our advantage? These issues will be discussed further in Chapters 6 and 12.

1.2.3 Reliability and validity of cognitive styles

Advocates of cognitive style research are not only faced with the challenge of defining styles and establishing the value and relevance of styles, but they have also been challenged on the instruments used to measure them and in particular, their reliability and validity.

Tiedemann (1989) believes that in cognitive styles research there is an "enormous gap between the conceptual and empirical level" (p.272). Tiedemann claims:

> "Broad theoretical constructs on the empirical level are often reduced to relatively simple – mostly laboratory – tasks measuring diverse abilities. Requirements of objectivity, reliability and validity are seldom fulfilled. Often heterogeneous measurement procedures, intercorrelating very low, claim to represent the same style construct. On the other hand, one and the same measurement procedure is used to describe different styles. These circumstances diminish the uniformity and delimitation of cognitive styles on the empirical level."
>
> Tiedemann, 1989, p.272.

Tiedemann's (1989) methodological criticisms of style research are not new. For example, Vernon (1963) criticised cognitive style research because it had largely evolved from theories generalised on single experiments and little empirical evidence resulting in problems with validity, reliability and generalisation. Furthermore, Lewis (1976) suggested that style research is often like following a fail-safe recipe whereby all researchers needed to do was the following:

1. Think of a cognitive style (and its negation); for example Impulsive and/or Reflective.
2. Think of a possibly related teaching style; for example, hurried and/or painstaking.
3. Think of a subject matter which, if taught in different ways, might establish a relationship between 1 and 2 above.
4. Dream up a success criterion, which will increase the chance of establishing a relationship between 1 and 2 above (for example, recall of facts/explanations).
5. Devise some test in the same spirit as 4.
6. Select a promising 'can't lose' design: for example, two styles and two student types.
7. Launch, analyse and verify.
8. Publish!

Lewis, 1976, p.302.

Although Lewis (1976) was referring to an area of style research called Aptitude Treatment Interaction, which examines the relationship between personal characteristics and situational variables, his sentiments can also be argued to apply to style research at the more general level. As Furnham (2000) said "style instruments are often tests that are looking for a theory."

1.3 Measurement of Cognitive Styles

Serious doubts about the empirical evidence for styles leads to the question of the kind of evidence needed for cognitive style measures to be considered valid and reliable. Riding (1997) argues that style measures need to fulfil the requirements of a style and the dimensions need to be objectively measured, independent of one another, separate from intelligence, independent of personality, demonstrate external validity and relate to physiological measures.

1.3.1 Fulfilling the criteria of a style

Styles have been measured in a variety of ways (Curry, 1990a). Typically, measurements of style are either accuracy based (e.g., Group Embedded Figures Test, Witkin, Ottoman, Raskin, & Kidd, 1971; Rod and Frame Test, Witkin & Asch, 1948a; 1948 b), speed based (e.g., Cognitive Style Analysis test, Riding, 1991. 1998) or self report measures (e.g., Learning Style Inventory, Kolb, 1976; Learning Styles Questionnaire, Honey & Mumford, 1992). Tiedemann (1989) believes that accuracy and reaction time based measures are not appropriate for style research because style is a preference measure, not a performance or an ability measure and a style measure should take this into account. Tiedemann suggests that Koestlin-Gloger's (1978) criteria should be used when measuring a preference dimension. Namely, it must be possible to find a solution, the answers must appear to be of equal value to the participant and during the testing session the participant must feel relaxed. This suggests that self-report measures may be the most appropriate type of style measure as they are not accuracy or performance based. However, self-report measures can be problematic because of their subjective nature. Overall, it seems that an important consideration for researchers when choosing or designing a style measure is whether or not the instruments are objective and preference based, rather than subjective and ability based.

Another problem with current style measures, is that several of them measure style on a unipolar scale whereby a high score implies the presence or strength of a style, whereas a low score is argued not only to be the absence of the style, but by default, the presence of the style on the opposite dimension. For example, performance on the Group Embedded Figures Test (Witkin et al., 1971) only measures whether someone is field independent. This opposite dimension, field dependence, is not tested, it is simply implied. Several style dimensions have been measured this way including Levellers and Sharpeners (Holzman & Klein, 1954) and Impulsivity-Reflectivity (Kagan, Rosman, Day, Albert & Phillips, 1964).

However, given that style dimensions are argued to be continuous, it is important that both ends of the dimension are tested, allowing for individuals to show preferences for the extremes of the dimension and in between the dimensions. In addition, unless the other dimension is empirically tested it is impossible to determine whether poor performance is due to the style, or due to other extraneous factors such as low motivation or failure to follow instructions (Riding & Cheema, 1991).

Overall, the research suggests that a good style measure should be preference based, stable, and it should measure both ends of the style dimension.

1.3.2 The objectivity of cognitive style

The objectivity of cognitive style measures is also important. Cattell and Warburton (1967) proposed that for a test to be unbiased it must be objectively scored: its method of assessment must not be obvious to the persons being tested. This should make it difficult for the persons taking the test to anticipate their results.

The objectivity of the various style measures varies considerably. Frequently, the purposes of the tests are obvious to the subjects, and as noted above, many tests are also self-report based, making the tests more subjective than empirical. Therefore, another important challenge for style researchers is to develop an objectively scored test that is not obviously measuring style differences.

1.3.3 The independence of cognitive style

For cognitive style to be considered valid, evidence is needed that style dimensions are substantially independent of each other and independent of personality and intelligence (Riding, 1997). Curry (1990a) notes that cognitive style researchers have consistently failed to demarcate between similar concepts resulting in almost no indication of the amount of overlap between the different learning and cognitive styles that have been proposed. In addition, the role that personality and intelligence play in determining and or influencing cognitive styles has also been debated but never clearly explained (Furnham, 1995). The problem is that researchers interested in the structure of personality and intelligence have largely ignored the possible role of cognitive styles and researchers interested in identifying particular styles have largely failed to relate or distinguish their findings from theories of personality and intelligence (Furnham, 1995). Furthermore, those researchers that have attempted to investigate the independence of cognitive style have reached different conclusions. For example Riding (1997), in his review paper titled 'The nature of cognitive styles', concluded that style is largely independent of personality and intelligence, whereas Furnham and colleagues have suggested that they are related (e.g., Furnham, 1992; Furnham, Jackson & Miller, 1999).

Therefore, consideration of whether a style instrument has demonstrated independence from personality, intelligence and other style measures is an important consideration when selecting a style test.

1.3.4 External validity of cognitive styles

Another important criterion for cognitive style instruments is evidence of external validity, which is the "extent to which it is legitimate to generalise findings to other people, places, times and instances of the variables measured" (Coolican, 1994, p.51). In general, very little emphasis has been placed on establishing external validity for style tests. Attempts to establish external validity are often conducted on convenience samples with narrow ranges of ability and very few have looked at cross-cultural differences (Biggs, 2001).

1.3.5 The biological basis of cognitive style

If a construct can be found to have a biological basis, then it can be argued to give the construct validity by linking it to something physical, observable and measurable. The theory is that a person's cognitive style may in some way limit the way their brain processes operations, or alternatively, their brain functions may affect their cognitive style. This should be reflected in measures of neurological function such as the brain's haemodynamic response to cognitive material, as can be detected by fMRI imaging. The only recent style construct to have specifically investigated whether it has a biological basis using non evasive methods is Riding's (1991) Cognitive Style Analysis (CSA) test. Riding, Glass, Butler and Pleydell-Pearce (1997) and Glass and Riding (1998) have found some evidence from EEG studies to suggest that performance on the CSA could be related to localised activity in the brain. More specifically, they found the wholistic-analytic style dimension showed primarily a mid-line alpha arousal effect and the verbal-imagery style dimension showed more lateralised and localised effects. However, the study only employed 15 subjects had low power, and the association between style and brain activity was not clear. In general, more substantial research is needed to establishing biological links between cognitive style measures and brain functions if any of the style tests are to be taken seriously as a measure of style.

1.4 The Reliability of Cognitive Styles Measures

The reliability of style measures is also an area that is vital but has lacked in-depth research. Curry (1990a) notes that most researchers have spent little time going through the processes of hypothesising, investigating and modifying, and then retesting. Instead, many researchers have "rushed prematurely into print and marketing with very little early preliminary indications of factor loadings based on one data set" (p. 51). Curry argues that this urgency to get into print seriously weakens claims of sound interpretations of test scores.

In any case, for a cognitive style measure to be reputable evidence of reliability is essential. There are two main ways of doing this. The first is to use test-retest reliability to see whether or not the same individual will produce a similar result twice. If the test scores taken at two different sessions by the same subject are highly correlated (e.g., a correlation of about above .7), then the test can be argued to be reliable (Coolican, 1994). Test-retest reliability is particularly important if the style measure is thought to be stable over time. Generally, cognitive styles are thought to be stable, but this stability has been conceptualised differently. For example, Chickering (1976) suggests that cognitive style may be stable but that stability does not necessarily mean it is fixed through education and training. Shapiro (1965) suggests that there may be a crystallisation process whereby frequent use of a particular style makes it highly activated and therefore more likely that it will be used later. In contrast, researchers such as Riding and Rayner (1998) believe that style is "probably present at birth or at any rate is fixed early on in life and it is thought to be deeply pervasive, affecting a wide variety of individual function" (p.7). In any case, if style is thought to be permanent and stable and if the right measuring instrument can be found, it should be possible to measure stable individual differences in style.

The other main form of reliability is internal consistency. This is usually measured using split-half reliability analysis or by computing Cronbach's alphas to examine the internal consistency of the test items. It is very important that all tests show some degree of internal consistency. Most popular style tests have demonstrated some acceptable degree of internal consistency (e.g., Dunn, Dunn & Price's 1996, Productivity and Environment Survey; Tait, Entwistle & McCune's 1998, Approaches and Study Skills Inventory for Students). However, unlike internal consistency results, test-retest reliability results are often not available. This may be because researchers have not tested for it or because researchers think there is no point in assessing it, especially if the style is thought to be modifiable by the environment (e.g., Tait et al., ASSIST). The sceptic's explanation might be that the measure was found to be unreliable so the findings were filed away rather than published.

Overall, considerable value is placed on having style measures that are internally stable and reliable over time. However, the value placed on the stability of individual differences in style over time can conveniently depend on how pervasive the style construct is thought to be. In other words, if a reliability test is conducted on a cognitive style measure and the test is found not to be reliable, the experimenter could argue that the results indicate that the style construct, rather than the measuring device, is not stable.

To summarise, it seems that for style instruments to be taken seriously they need to have the following: i) a defined construct that they are measuring; ii) a reliable and objective measure; iii) evidence that the construct is independent of personality, intelligence, and other style dimensions; iv) demonstration of external validity; and v) evidence of a biological basis would also be beneficial.

1.5 What styles have been proposed: do they meet the proposed standard?

Many different models of style have been suggested. Messick (1976) identifies 18 different learning styles, Riding and Cheema (1991) identified over 30 and Desmedt and Valcke (2002) identified over 125 models in scientific and popular literature. The amount of research and attention each style instrument has attracted has varied considerably, resulting in some reviewers dividing styles up into 'best established' and 'other' (Guilford, 1980). Table 1.2 outlines some of the major style dimensions and instruments and what each one is believed to assess. Based on the reviews of Rayner and Riding (1997), Riding and Cheema (1991), Tiedemann (1989) and Kline (1995), Table 1.3 outlines whether there is evidence for these major cognitive style measures being substantially independent of other styles, personality and intelligence. They also describe if there is any evidence indicating validity, reliability and a biological basis. Table 1.3 suggests that many of the major cognitive style instruments suffer from inadequate amounts of published evidence demonstrating reliability and validity. The test that appears to meet most of the criteria, Riding's 1991 CSA, is also one of the more recently developed tests (this test will be discussed further below and in more detail in Chapter 3).

Table 1.2
List of some of the major style dimensions that have been proposed, a description of them and the name of the instruments designed to test them. Examples taken from Rayner & Riding (1997); Riding & Rayner (1998); Tiedemann (1989).

Style Name	Description	Type of Test	References
Field Independence-Dependence	Examines whether people can separate relevant and irrelevant cues in perceptual tasks. Those who can are called field independent, those who can not are called field dependent.	Body Adjustment Task Rod and Frame Task Group Embedded Figures Task (all empirical tasks)	Witkin (1950) Witkin & Asch (1948a & 1948b) Witkin et al. (1971)
Impulsivity-Reflectivity	Investigates tendency to use impulsive rapid, inaccurate scanning (impulsive) or cautious, slow, accurate scanning (reflective).	Matching Familiar Figures Test (pen and paper accuracy test)	Kagan (1964; 1965)
Levellers and Sharpeners	Explores whether people simplify perceptions and assimilate new and old information (levellers), or perceive things as complicated and examine the detail without assimilation (sharpeners).	Schematizing Test (questionnaire based test)	Hollingworth (1913) Klein (1954)
Category Width	Investigates preference for wide inclusive categories or narrow exclusive categories.	Many different tests including: 1. Category Width Scale 2. Range Width Scale (questionnaire based)	Pettigrew (1958) Fillenbaum (1959)
Divergent and Convergent Thinking	Preference for original, broad, open ended associational problem solving (divergent) or logical, deductive focused problem solving (convergent).	Many different tests including: 1. Use of Objects Test 2. Consequence Test 3. Matching Familiar Figures (both empirical and questionnaire based)	Guilford (1967)

Table 1.2 continues

Table 1.2 continued

Style Name	Description	Type of Test	Reference
Holist Serialists	Investigates tendency to assimilate the detail into a whole when learning and problem solving (holist) or to work step by step (serialist).	Scenario based tasks (questionnaire based)	Pask &Scott (1972)
Learning Styles Inventory	Measure of environmental, sociological, emotional, physical and psychological learning preferences.	Questionnaire	Dunn, Dunn & Price (1977)
Verbaliser-Visualiser Questionnaire	Tendency to use imagery or preference for verbal information.	Questionnaire	Richardson (1977)
Cognitive Styles Analysis	Examines preference to structure information in wholes or parts and represent information in words or pictures.	Computerised reaction time empirical task	Riding (1991)
Experiential Learning Style	Investigates preferred perceptual mode (concrete or abstract) and preferred processing mode (active or reflective).	Questionnaire	Kolb (1976)
Learning Styles Questionnaire	Analyses preferred mode or approach to learning. Groups people into four categories (activists, theorists, pragmatists or reflectors).	Questionnaire	Honey & Mumford (1986; 1992)
Myers-Briggs Type Indicator	Analyses people into 8 Jungian Types based on extraversion, introversion and thinking, feeling, sensing and intuition.	Questionnaire	Myers (1978)

Table 1.3.
Summary of some of the major style dimensions and whether there is evidence for them being independent of other styles, personality, and intelligence, and if they have investigated a possible biological basis, how much evidence there is for external validity and reliability and the amount of research carried out on the style. The summary is based on the reviews of Rayner & Riding (1991), Riding & Cheema (1991) Tiedermann (1989), Kline (1995), and Richardson (1999).

Style Name	Type of Measure	Independent of other Styles	Independent of Personality	Independent of Intelligence	Biological Basis	Degree of External Validity	Reliability (test-retest)	Amount of Research
Field Independence-Dependence	Accuracy	No	No	No	Some	Average	Debated	Much
Impulsivity-Reflectivity	Accuracy	Debated	Debated	Unknown	Unknown	Some	No	Some
Levellers and Sharpeners	Accuracy	No	Unknown	Unknown	Unknown	Some	Unknown	Little
Category Width	Accuracy and Preference	No	Unknown	Debated	Unknown	Some	No	Little
Divergent and Convergent Thinking	Accuracy and Preference	Debated	Unknown	Unknown	Unknown	Some	Unknown	Some
Holist Serialists	Preference	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Some
Learning Styles Inventory	Preference	Unknown	Unknown	Unknown	Unknown	Much	No	Some

Table 1.3 continued

Table 1.3 continued

Style Name	Type of Measure	Independent of other Styles	Independent of Personality	Independent of Intelligence	Biological Base	Amount of External Validity	Reliability (test-retest)	Amount of Research
* Learning Styles Questionnaire	Preference (questionnaire)	Unknown	Unknown	Unknown	Unknown	Some	Some	Some
* Myers Briggs Type Indicator	Preference (questionnaire)	Unknown	No	No	Unknown	Much	Much	Much
Verbaliser Imagery	Preference (questionnaire)	Unknown	Unknown	Unknown	Unknown	Debated	No	Little
Cognitive Styles Analysis Test	Preference (reaction time)	Yes	Yes	Yes	Some	Much	None	Much

* These styles have been argued to assess more general learning styles as opposed to the others which are more instruments designed to test cognitive styles (Rayner & Riding, 1997; Kline, 1995)

1.6 An integration of Styles research

Given the perception of style research as "a cacophony of labelling theory and psychometric instability" (Armstrong & Rayner, 2002), it is easy to see why Tiedemann in 1989 said "Life is short and so my personal opinion on the state of research into cognitive styles has to be: there is no point chasing a chimera!" (p.273). Although Tiedemann's approach to the confusion was to abandon style research, style advocates chose to change tack rather than admit defeat. Towards the end of the 1980s style researchers started to make concerted attempts to integrate the styles literature. They realised that adding another new style model was not necessarily progress (Desmedt & Valcke, (2002). As Desmedt and Valcke said "applications of cognitive and learning styles can only be justifiably developed if the muddle of different existing theoretical orientations is cleared up" (p.3). Some of the better known attempts to integrate the style literature have been made by Curry (1983), Miller (1987) Riding and Cheema (1991), Grigorenko & Sternberg (1995), Riding & Rayner (1997) and Sternberg (2001). Desmedt and Valcke however, criticise these reviews for being inconsistent, not exhaustive, having no clear distinguishing criteria, no consideration of differences in scientific impact, being biased to the views of the reviewer and having limited information about the context in which the style models were developed. It was these criticisms that led Desmedt and Valcke to conduct a citation analysis of the literature, which avoids some of these problems by using citation rates of authors and citation links to deduce the important style measures, rather than a priori selecting the style measures of interest. The findings of the Desmedt and Valcke study will be discussed further below. Although Desmedt and Valcke (2002) raise legitimate concerns about the style review process, the reviews did have their benefits. In particular, they helped provide a variety of frameworks on which researchers could build, rather than repeatedly going over old ground.

One of the most cited reviews is Riding and Cheema's (1991) paper titled 'Cognitive Styles – an overview and integration'. Presland (1994) refers to this paper as "a valiant attempt to give some structure to the body of knowledge in this area and to suggest ways forward" (p.179). Riding and Cheema surveyed approximately 30 different cognitive styles and after comparing their descriptions, assessment method, correlations between them and examining their influence on behaviour, they concluded that most of them measured two broad dimensions of cognitive style: the verbal-imagery dimension and the wholistic-analytic dimension. Riding (1991, 1998) subsequently proposed a new computerised Cognitive Styles Analysis (CSA) test, which measures cognitive style on these two broad dimensions.

Riding's (1991) CSA test of verbal-imagery and wholistic-analytic cognitive style was seen as a breakthrough by many cognitive style researchers. This was largely because, compared to many earlier style measures, the test has been the object of a substantial amount of published work (including providing evidence of the CSA's validity, see Table 1.3), the test is easy to administer, it is available in seven languages, and perhaps most importantly, the CSA's dimensions (wholistic-analytic and verbal-imagery) appear to have grown out of existing style theories. In particular, the CSA's wholistic-analytic dimension was argued to broadly encompass style theories such as Field Dependence-Independence (Witkin & Asch, 1948a, 1948b), Holist-Serialist (Pask & Scott, 1972), Levelling–Sharpening (Klein, 1954) and Impulsivity-Reflectivity (Kagan et al., 1964) (Riding & Cheema, 1991). Indeed, it is Witkin & Asch's Field Dependence-Independence dimension which Desmedt & Valcke's (2002) identified in their citation analysis as being the base from which most style research has grown.

The verbal-imagery dimension is historically less established. However Riding and Cheema (1991), argued that it broadly encompasses the ideas of Dual Coding (Paivio, 1971), the Verbaliser-Visualiser Questionnaire (Richardson, 1977) and the Verbal-Imagery Code test (Riding & Calvey, 1981) (see Riding & Rayner, 1998 for a review).

In conclusion, over the past 60 years many different style models have been proposed, but few have been rigorously tested for reliability and validity. In an attempt to sift out the better measures, researchers such as Messick (1984), Tiedemann (1989), Riding (1997), Furnham (1995) and Adey et al. (1999) published definitions and criteria that they thought were important for style measures to meet. In addition, in the late 1980s researchers started to try to integrate some of the style models and research. One key review was Riding and Cheema's (1991) paper which led to the suggestion that there were two broad style dimensions: verbal-imagery and wholistic-analytic. Riding (1991) subsequently proposed a computerised measure of these dimensions (the CSA) and provided empirical and theoretical evidence to support them. Currently the CSA is one of the most popular style measures in the UK and its test author (Richard Riding) has the second highest number of publications in the cognitive style field (Desmedt & Valcke, 2002). The only criterion that stands out as not having been tested is the CSA's reliability and internal consistency (see Table 1.3).

Chapter 2 will outline in more detail the nature of the CSA and examine more closely the empirical evidence that supports it. Chapter 3 will investigate the CSA's test-retest reliability and internal consistency.

Chapter 2

The Cognitive Styles Analysis Test

As noted in Chapter 1, Riding's (1991) Cognitive Styles Analysis (CSA) is a popular style measure that has been used in numerous publications with considerable reported success. This chapter will outline in more detail the nature of the CSA test and the evidence that has been used to support it.

2.1 Introduction to the CSA test

2.1.1 The CSA's dimensions

The CSA measures style on two dimensions: verbal-imagery and wholistic-analytic. The verbal-imagery dimension assesses whether an individual prefers to represent information during thinking verbally or in mental pictures. In other words, verbalisers prefer to learn from spoken or written words, whereas, imagers find text easier to understand when it is accompanied with information presented in pictures or diagrams (Adey et al., 1999).

The wholistic-analytic dimension looks at whether people prefer to process information in wholes or in parts. More specifically, wholists are argued to be people who prefer to have an overview of an area first and they typically like to make decisions based on the overall picture. The advantage of this style is that they can see the bigger picture without being side tracked by the smaller issues that can be added in later. The disadvantage of the style, in its extreme form, is that people can make decisions too quickly without considering the detail. In contrast, analytics like to examine the detail and to build up their understanding by analysing things in parts. The advantage of this style is that people can gain an in-depth detailed understanding of issues, but at its worst, it can lead to no integration or real understanding of the bigger issues (Adey et al., 1999).

2.1.2 The CSA's structure

The CSA is a computerised test that comprises three reaction time based sub-tests. The first sub-test assesses the verbal-imagery dimension by visually presenting printed statements one at a time, which are judged as being either true or false. Half of the statements involves comparing the colour of objects (e.g., "Are Tar and Coal the same colour?"), and the other half involves comparing the conceptual categories to which items belong (e.g., "Are Hockey and Soldier the same type?"). The test measures whether participants respond faster to the colour statements (imagery section of the test), or the conceptual category statements (verbal section of the test). It is assumed that the imagers will respond quicker to the appearance of colour statements, because they can easily transform the items into visual pictures and therefore, the information required for this comparison can be obtained directly and efficiently from these images. In contrast, it is proposed that verbalisers will respond quicker to judgements that involve comparing the semantic conceptual category of items because they have quicker access to semantic information than they do to information concerning images.

To determine an individual's cognitive style, the CSA computer programme records the average response time to the verbal statements and the average response time to the imagery statements and then calculates a verbal-imagery ratio between the two averages. The absolute value of the reaction times on the verbal and imagery items are themselves of little interest, as they tell us nothing about the relative differences between the responses to the verbal and imagery sections, whereas, the verbal-imagery ratio gives an indication of the verbal-imagery style preference. Once the verbal-imagery ratio has been calculated, the CSA allocates a style category based on the value of the reaction time preference ratio. If the value of the ratio is low, it corresponds to a verbaliser and if the value of the ratio is high it corresponds to an imager; anything in between is called bimodal.

The second two sub-tests of the CSA assess the wholistic-analytic dimension, also using a reaction time measure. The first of these involves judging whether pairs of complex geometrical features are the same or different (e.g., Figure 2.1). This is similar to Kagan's (1965) Matching Familiar Figures task. This task is based on the premise that it will be easier

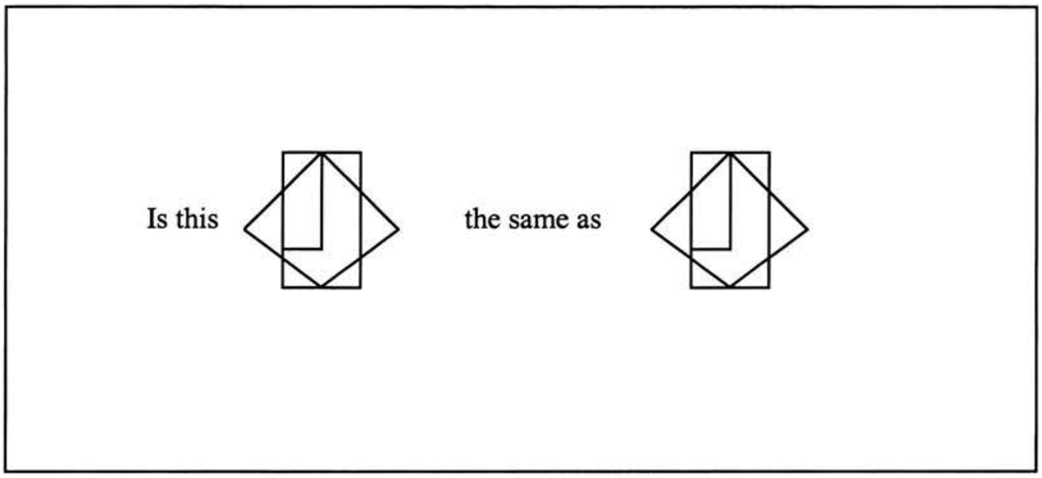

Figure 2.1
Example of the type of wholistic item used in Riding's (1991, 1998) CSA Test

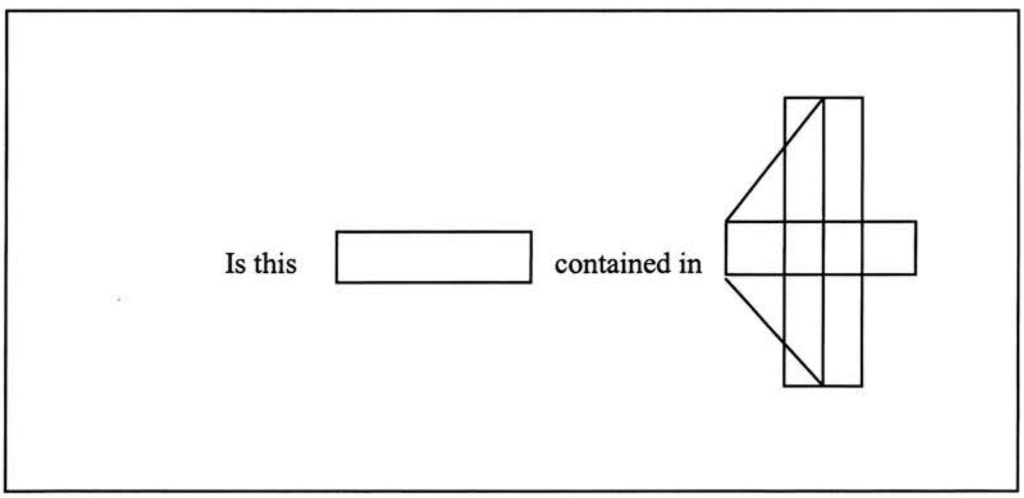

Figure 2.2
Example of the type of analytic item used in Riding's (1991, 1998) CSA test

for wholists than for analytics because wholists are quicker at monitoring the overall similarity of the two objects. In the third sub-test, subjects are presented with a simple shape and asked to indicate if that shape is embedded in a more complex figure (e.g., see Figure 2.2). This is similar to Witkin et al., (1971) Embedded Figures Test. This task is thought to be easier for analytics, as opposed to wholists, because analytics find it easier to focus on detail. Like the verbal-imagery dimension, the computer records the average response times to the wholistic and analytic sub-tests and generates a wholistic-analytic reaction time preference ratio which indicates the individual's wholistic-analytic style preference. A low ratio corresponds to a wholist and a high ratio to an analytic, anyone with a ratio in between is called an intermediate (Riding, 1998).

2.2 The Validity and Reliability of the CSA

As noted in Chapter 1, Riding (1997) argues that for a style measure to have construct validity, the dimensions need to: i) be objectively measured; ii) fulfil the requirements of a style; iii) be independent of one another; iv) be separate from intelligence; iv) be independent of personality; v) be related to observed behaviours and vi) be related to physiological measures. For reliability, cognitive style should ideally show test-retest reliability and internal consistency. The CSA will be examined against these criteria below.

2.2.1 Measurement

One advantage of the CSA over other style dimensions (e.g., Group Embedded Figures, Impulsive-Reflectivity and Levellers and Sharpeners) is that it positively measures both ends of the two style dimensions, i.e., it tests both the verbal and imagery dimension and the wholistic and analytic dimension.

Furthermore, style preferences are computed by calculating the verbal-imagery reaction time ratio and the wholistic-analytic reaction time ratio (with the ratio allowing the experimenter to look for relative style preferences on each dimension). However, the participants are led to believe that it is the accuracy with which they respond that is being measured. Therefore, the method of assessment is not obvious to those being tested. In addition, the use of a reaction time ratio measure to determine cognitive style preference, rather than using accuracy or a self-report questionnaire, is also more in keeping with Cattell and Warburton's (1967) criteria for an objective test (see section 1.3.2). More specifically, it does not contain self-report questionnaire items or complicated language making it difficult for some age ranges. Also, it is argued to be context and culture free, being suitable for deployment in schools, businesses and industry, it has been used in a variety of countries and the test is available in seven languages (Riding & Rayner, 1998). Finally, the use of the style ratio, rather than the raw reaction time scores on each end of the dimension, helps remove any ability factor that might be associated with high mean scores on any one end of the dimension.

2.2.2 Independence

Correlations between the wholistic-analytic style ratios and verbal-imagery ratios, according to Riding (1997), are consistently low, typically $r = 0.1$. Furthermore, no significant correlation between age and Riding's cognitive styles have been found and no difference in cognitive styles have been found between genders (Riding & Douglas, 1993; Riding & Read, 1996; Riding & Rayner, 1998).

Riding (1997) also claims that cognitive style, as measured by the CSA, is independent of intelligence. In support of this, Riding and Pearson (1994) sampled 119, 12-13-year-olds and correlated their intelligence as assessed by the British Ability Scale (BAS) with cognitive style measured on the CSA. Riding and Pearson found no significant correlation between the four sub-tests of the BAS (recall of digits, similarities, matrices and speed of processing) and the person's cognitive style ratio on the CSA.

Similar findings have been found by Riding and Agrell (1997) who tested 205, 14-16-year-olds on the Canadian Test of Cognitive Skills (CTCS), which is similar to the Wechsler Intelligence Scale for Children. Riding and Agrell found that the participants' scores on the CTCS had very low correlations with the wholistic-analytic and verbal-imagery ratios. However, Riding and Agrell noted that style and intelligence interacted with school achievement in that the style category was more critical when pupils were of a lower ability and the subject did not suit their style. For example, the analytic-vebalisers academically performed the best and the analytic-imagers performed the worst. Riding and Agrell claimed that the reason why analytic-verbalisers appeared naturally suited to all subjects was probably because all subjects require a degree of verbalisation, together with the need to analyse. In contrast, analytic-imagers appeared the least academic, because they lacked the fluent verbalisation (Riding & Agrell, 1997).

Riding and Agrell (1997) suggested that when people's styles are naturally inappropriate to school work, and when they are intelligent, they are likely to develop strategies to help maximise the effectiveness of their style. In other words, intelligent people will work out strategies for themselves, while less intelligent people may need more help to find a strategy that makes the most of their style. Therefore, Riding and Agrell's findings suggest that style, as measured by the CSA, does not appear to be directly associated with intelligence, but style may interact with subject performance, depending on the nature of the subject and the type of instruction.

Riding and colleagues have also investigated whether the CSA is independent of personality. Riding and Wigley (1997) tested 240, 16-18-year-old education students on the CSA and then gave them a series of questionnaires which measured extroversion, neuroticism, psychoticism, impulsiveness, venturesomeness, empathy, state and trait anxiety. Factor analysis gave four factors that were called anxiety, activation, empathy and style. The results of the analysis revealed that none of the personality measures loaded more than 0.1 onto the style ratio. Therefore, it appeared that cognitive style and personality were not tapping into or assessing the same construct. Riding and Wigley consequentially argued that this independence was justification for ruling out the likelihood of individual differences, in for example motivation, affecting style and overall performance (Riding & Wigley).

2.2.3 External validity

As well as demonstrating the CSA's independence from a variety of measures, Riding and colleagues have conducted numerous experiments exploring the external or predictive validity of the CSA. Research findings have found that the CSA seems to be predictive of a variety of behaviours.

For example, Riding's cognitive style dimensions have been reflected in people's preferred mode of processing. Riding and Douglas (1993) presented 58, 15-16-year-olds with information on the functioning of a car braking system in text and pictorial form and then assessed them on immediate recall, problem solving questions, labeling questions and explanation questions. They found that in the text + picture condition, the imagers did better than verbalisers and in the text + text condition, the verbalisers were superior to imagers. In addition, 50% of the imagers used illustrations as part of their answers, compared to 12% of the verbalisers. This was believed to suggest that imagers learn better with pictorial presentations and verbalisers learn better from verbal presentations.

In addition, Riding and Read (1996) found that style, measured by the CSA, was related to an individual's learning preference. Riding and Read questioned 78, 12-year-olds about their preference for English or Science with regard to the preferred mode of working, preferred type of task and social context. The main findings were that imagers reported that they liked more pictures and less writing than the verbalisers and group work was the most popular with wholists, especially lower ability wholists and imagers. Furthermore, individual work was least disliked by analytics, particularly in the case of higher ability verbalisers.

Relationships between style on the CSA and behaviour problems have also been found. Riding and Craig (1998) assessed 83, 10-18-year-olds in a special school for children with behavioural problems (e.g., bullying, aggressive, violent and temper) and found, for example, that wholists and verbalisers were more likely to have behavioural problems. Riding and Craig suggested that this might be because wholists are likely to be less structured than analytics and therefore, wholists may lack in-built self control resulting in less restrained behaviour. The reason verbalisers feature as having behavioural problems may be that their verbal fluency is more obvious and observable than that of the imagers.

Riding and colleagues have also provided further evidence that cognitive style, as measured by the CSA, is related to preferred structure of learning material (Riding & Sadler Smith, 1992; Riding & Douglas, 1993), preferred type of learning content (Riding & Dyer, 1980), preferred subject (Riding & Staley, 1998) and levels of stress (Borg & Riding, 1993). These findings all add to Riding's (1997) claim that the CSA has high external or predictive validity.

2.2.4 Biological basis

Riding et al. (1997) and Glass and Riding (1998) investigated whether individual differences in cognitive style are reflected in differences in cerebral functioning. The specialisation of one cerebral hemisphere for verbal functioning and the other for visuo-spatial functioning has long been established (Riding et al., 1997). However, individual differences in cognitive style, especially the wholistic-analytic style, have not been clearly linked to differences in cerebral functioning.

Riding et al. (1997) measured the EEG alpha waves of 15 subjects while they performed a computer task. The alpha wave reflected the degree of local cortical activity, whereby suppression indicated that the region had become active (Riding et al., 1997). The task involved responding to whether any of the words, which were visually presented in groups of 2, 5 or 10 per second, were from the category of fruit or vegetables. The task was analytic in that the words had to be separated into category or non-category and it was visual, in that it contained groups of nouns. The participant's cognitive style was also assessed using the CSA test. Those subjects identified by the CSA as analytics showed greater suppression of the alpha band output than the wholists, suggesting more processing by the analytics. This was argued to be a logical result given that the task was primarily analytic. On the verbal-imagery dimension there was a relationship between the area of activity and the verbal-imagery dimension such that t5 (left posterior temporal cortex; Wernicke's area for speech reception) was more active in verbalisers than in imagers. This effect is particularly noticeable in the slower task, which would have allowed fuller processing of verbal and imagery based processing (Riding et al., 1997). In comparison, imagers showed greater suppression of alpha waves than the verbalisers did on t4 and t6 (right temporal lobe anterior posterior track) which is associated with conceptual categorisation (Riding et al., 1997).

Riding et al. (1997) state that these findings do not suggest that styles have their own source within the cortex, but they do suggest that cognitive styles could be related to localised brain activity as indicated by the EEG output. Note that subject numbers in Riding et al.'s experiment were low and more evidence is needed to confirm these findings.

2.2.5 Reliability

As noted in Chapter 1, empirical evidence for the test-retest reliability of most style measures is scarce. Unfortunately the CSA is no exception and its lack of empirical evidence showing reliability is arguably its largest downfall. Riding (1991) claims that to some extent the reliability of the CSA is built into the test. That is, Riding argues that the measure of the error rate enables the researcher to determine whether or not the subjects understood the test and took the test carefully and seriously. However, no research appears to have been done on the test-retest reliability of the CSA and no internal consistency measures have been conducted because Riding (1991) argues that there are insufficient items to perform the statistical tests.

In conclusion, the CSA makes some strong claims about its advantages over other measures of cognitive style, claiming that it is an objective test that is substantially independent of intelligence, personality and other style dimensions, it is related to observed behaviour and it has biological links (see Table 1.3). However, little research has been done on its internal consistency and reliability. This is unsatisfactory given its growing popularity as a measure of cognitive style in the UK.

Furthermore, the commercial nature of the CSA means that researchers are only given summary statistics on completion of the test and therefore, to date, they have been unable to closely examine the effects of the CSA's structure on participant performance (e.g., researchers cannot see which items subjects tend to get wrong etc.). Therefore, Chapter 3 will examine the structure and design of the CSA and its effects on participant performance as well as its reliability and internal consistency.

Chapter 3

The CSA's Reliability and the Extended CSA-WA's Development

This chapter has four main aims. Firstly, to review the CSA's design and examine the effect of its structure on subject performance. Secondly, to discover whether a parallel CSA test could be constructed that would generate the same style prediction for each subject as the original CSA. Thirdly, to examine the test-retest reliability of the style prediction for both the original CSA and a parallel version of the CSA approximately a week later. Finally, to investigate whether the CSA test could be improved.

3.1 A Brief Review of the Structure and Measurement of Style on the CSA

Riding's CSA is divided up into three parts which take about 25 minutes in total to complete (see Chapter 2). The first part assesses people's place on the verbal-imagery dimension and the second and third parts assess people's place on the wholistic-analytic dimension.

3.1.1 The verbal-imagery section

The items that are used to tap into the verbal-imagery dimension require a judgement to be made on either the similarity of two items' colour (e.g., "Are Postbox and Strawberry the same colour?"), or the similarity of two items' categorical type (e.g., "Are Skiing and Cricket the same type?"). Riding (1991) claims that a person who prefers to represent information using imagery will be able to create a mental image of the items and compare the colour of the two items faster than they can verbally compare the semantic category of two items. In contrast, Riding claims that individuals who prefer to represent information verbally will be able to compare the similarity of conceptual categories quicker than they can compare the images of items.

3.1.2 The wholistic-analytic section

The measurement of the wholistic-analytic dimension requires a judgement to be made about two sets of shapes. The first set requires subjects to judge whether two complex figures are exactly the same shape (see Figure 2.1). This test is designed to measure the wholistic dimension. The second set involves judging whether a single shape is embedded within a more complex shape, which is a test designed to measure the analytic dimension (see Figure 2.2). Like the verbal-imagery dimension, a person who prefers to analyse information using a wholistic approach is assumed to respond faster on the wholistic items than the analytic items and vice versa for those that prefer to process information using an analytical style.

3.1.3 Measurement and calculation of cognitive style

In order to measure a subject's style preference on the CSA, two measures are taken. An accuracy measure and a reaction time measure. Riding (1998) assumes that if the subjects are performing with an accuracy of greater than 65% they can be argued to have understood the task and be attempting to answer it appropriately.

To calculate the preferred cognitive style on the verbal-imagery dimension, a ratio of the time taken to respond on the verbal items as opposed to the imagery items is taken. Similarly, to calculate the preferred cognitive style on the wholistic-analytic dimension, a ratio of the time to take to respond on the wholistic items as opposed to the analytic items is taken. These ratios (verbal-imagery and wholistic-analytic) are then usually compared to norms[1] resulting in subjects being allocated to one of nine possible different style categories (see Table 3.1). Therefore, each of Riding's two style dimensions is based on the ratio of two reaction times to different types of questions.

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[1] The norms are based on a standardised sample of 999 UK subjects (Riding, 1991, 1998).

Table 3.1
The groupings of cognitive style dimensions as proposed by Riding (1991, 1998).

Style divisions on the wholistic-analytic dimension based on the wholist to analytic ratio of reaction time in ms	<1.35	Analytic Verbaliser	Analytic Bimodal	Analytic Imager
	>1.02 and <= 1.35	Intermediate Verbaliser	Intermediate Bimodal	Intermediate Imager
	<= 1.02	Wholist Verbaliser	Wholist Bimodal	Wholist Imager
		< 0.98	> 0.98 and <= 1.09	>1.09
	Style divisions on the verbal-imagery dimension based on the verbal to imagery ratio of reaction time in ms			

3.2 Critique of the CSA

3.2.1 The design and structure of the verbal and imagery questions

One potential problem with the verbal-imagery dimension is its use of subjective questions to assess style. Specifically, the imagery dimension asks the question "Are X and Y the same colour?" and the verbal dimension asks the question "Are X and Y the same type?" Both of these questions may have more than one correct answer as few objects are purely one colour or type and very few objects are exactly the same colour or type. For example, Riding's CSA requires subjects to judge whether mud and chocolate are the same colour. However, both these objects can be argued to be different colours; mud can be argued to be shades of brown or black; and chocolate can be argued to be white or various shades of brown. In this sense, neither mud nor chocolate are exactly the same colour. For some individuals, perhaps especially those who are sensitive to imagery or who are more analytic, the 'correct' answer given by the CSA may conflict with their own perceptions and this conflict may slow their reaction time. As the CSA measures style based on the assumption that participants respond faster to their preferred style, it is possible that the test may identify people as verbal that are actually strong imagers, or possibly also those that are strong analytics (who may look for detail). Other items that the CSA argues are the same colour that may cause similar problems include: cream and paper; ice and glass; and postbox and strawberry.

Similar arguments can be made about the measurement of the verbal dimension. Although the CSA does give an example on how to answer the verbal items,[2] which shows that it is the broad categorical comparison that is considered correct this may also be problematic. The most obvious example of this is the use of the question "Are Beans and Chicken the same type?" At the broadest level beans and chicken could both be considered food and therefore the answer is "Yes" they are the same type (which is the correct answer on the CSA). However, beans can also be categorised as vegetables, and chicken as an animal in which case the participant might respond "No" they are not the same type. Therefore, it is possible that a person's conceptualisation of the category or categories that these items belong could depend on how broadly he or she tended to group objects (i.e., whether they were wholistic), and also in this particular case, on his or her background and socialisation. For example,

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[2] Note, no examples are given on how to answer the imagery items.

vegetarians are arguably more likely to make a clear categorical distinction between beans and chicken. Examples of similar categorical conflicts on the CSA, include comparing fork and spade, and comparing curtain and rug which, according to the CSA, are the same category types. Therefore, it is possible that verbalisers, and especially analytical verbalisers, may find the items designed to assess the verbal dimension on the CSA conflict with their own views. This may slow down their response times which makes their reaction time scores on the verbal dimension an inaccurate representation of their style.

Overall, it is likely that items that have more than one obvious correct answer and items that claim to be the same colour or type are more likely to cause confusion in subjects' responses than items that are clearly correct or incorrect and clearly different colours or types.

In contrast, the wholistic and analytic items have an obvious correct answer. On the wholistic section of the test, the items are either exactly the same or they are not. In the analytic section of the test, the shape is either embedded in the larger figure or it is not. Due to the fact that wholistic-analytic items seem to form a more objective test than the verbal-imagery dimension items, it is likely that scores on the wholistic-analytic dimension will be more reliable over time than scores on the verbal-imagery dimension.

3.2.2 Measurement and calculation of the cognitive style ratio

The use of reaction time as the dependent variable on the CSA has several disadvantages. As noted above, the CSA looks for style preferences using a style preference reaction time ratio. That is, the average reaction time on the verbal items is compared to the average reaction time on the imagery items (creating the verbal-imagery style preference ratio) and the average reaction time on the wholistic items is compared to the average reaction time on the analytic items (creating the wholistic-analytic style preference ratio). One problem with using reaction time is that if subjects are distracted or motivation is low, then reaction time data can be easily skewed and can become a misleading measure. Riding (2000) claims to avoid this problem in part by taking a "modal" response time to calculate the cognitive style preference ratio. However, using the mode to calculate the reaction time style preference ratio is an unusual measure to take, as it is unlikely that any two reaction times will be precisely the same. A more appropriate measure to use for the style preference reaction time ratio is to use the median reaction time, which is less affected by outliers than the mean and more useable than the mode.

Another problem with using reaction time as the dependent measure is that when subjects answer questions incorrectly, their response to the subsequent item is likely to be slower. This could be problematic in the verbal-imagery dimension where the verbal and imagery questions are mixed together. For example, a verbal item may be followed by an imagery item and if the verbal item is answered incorrectly, it is likely to slow the response time on the subsequent imagery item due to the subject becoming more cautious. If this happened on several occasions, it could bias the test towards identifying a person as a verbaliser, as this would attract an overall faster response time.

The way an individual's preferred cognitive style category is allocated is also problematic. Riding (1991, 1998) admits that the division of people into nine style categories based on their verbal-imagery style ratio (their average reaction times on the verbal items over the average reaction time on the imagery items) and wholistic-analytic ratio (their average reaction times on the wholistic items over their average reaction time on the analytic items) is to some extent arbitrary[3]. However, the subjects themselves are not told this. On completion of the CSA subjects are only told what their style is; no indication of how strongly they are that style type is given. Perhaps a less misleading approach would be to plot the ratios on a scale enabling the individual to interpret their own score. This would prevent people who were .01 ms below or above a cut-off point being defined, perhaps inappropriately, as one particular style and allow the more arbitrary nature of the divisions to be public.

3.2.3 The CSA's evidence for reliability

Despite the fact that a considerable amount of work has been done on establishing that cognitive style dimensions, as measured by the CSA, are "independent from one another, separated from intelligence, independent of personality, related to observed behaviour and related to physiological measures" (Riding, 1997, p. 33.), little work has been done specifically on establishing the CSA's reliability.

As noted in Chapter 2, Riding (1991, 1998) claims that to some extend the reliability of the CSA is built into the test, in that the measure of the error rate enables the researcher to

[3]Note also, that in empirical studies Riding and colleagues often just divide the subjects into three equally sized groups irrespective of the norms so as to get equal numbers of subjects in each style category (e.g., Riding & Read, 1996; Riding & Sadler-Smith, 1992). See Chapter 11 for more details.

determine whether or not the subjects understood the test and took it carefully and seriously. However, no research appears to have been done using the test-retest reliability method and no internal consistency measures have been taken. Therefore, the stability and internal consistency of the CSA's style dimensions have not been empirically verified.

Although Riding (1991, 1998) did say that a "reasonably long interval is required between test presentations" (p.8) and he suggests the need for a long-term test-retest reliability study over a period of about a year, he only provides cited empirical evidence (Riding, 1982) to suggest that the test-retest needs to be over a week (Riding, 1982). More specifically, Riding (1991,1998) cites an earlier study by Riding (1982) which found that response latencies to items that had previously required some kind of judgement were reduced one week later when the same judgement items were presented. Riding (1982) suggested this was because the judging of a statement involves the complete retrieval of the possibilities followed by a comparison process, which together cause the item to be deeply encoded. In addition, the semantic pathways associated with the comparison are thought to be at a higher state of activation which may facilitate faster recall at retest. Therefore, although Riding suggests the need for test-retest reliability over a period of about a year he only gives evidence to suggest that a test re-test interval of less than a week could change the raw reaction times. Herein lies another important reason as to why the short test-retest interval should not matter: a short test-retest interval may affect the reliability of the absolute reaction times, but it should not affect the reliability of the reaction time ratios on which style preference is based. As noted above, this is because the ratio looks at the relative reaction time differences between the verbal-imagery and wholistic-analytic items, not the absolute values of the reaction times. Therefore, a participant sitting the test again after a short space of time may respond faster on all aspects of the test, but provided that the decrease in reaction time is roughly linear then the relative preference for one particular style should be consistent over time.

The alternative reliability measure, split-half reliability, has also not been conducted on the CSA. This method, which involves re-analysing the test data by dividing it in half, to see if the same test result can be generated from each half of the test data, avoids the problem of subjects remembering items they have previously been exposed to. Riding (1991) argues that no split-half reliability measures have been carried out on the CSA because the number of items on the CSA may be the minimum number that could reasonably be expected to get a result due to the reaction times being frequently so diverse. Therefore Riding claims that dividing test items in half to get split test reliability may reduce the number of items in the CSA to a level that is too low. In addition, Riding (1991) proposes that extending the test and creating more items may make it too long for an individual to do without fatigue. The alternative to this is to design a parallel test that can independently assess whether the test is reliable.

The present study aimed i) to examine more closely how the different sections of the CSA affected performance by looking in particular at the errors and the reaction times on each section and on each item; ii) to investigate whether a parallel version of Riding's (1991) CSA could be constructed; iii) to investigate whether the CSA style preference ratios and the parallel version of the CSA (CSA-B) style preference ratios could reliably predict the same style types both at time 1 and at retest approximately a week later; iv) to investigate whether the CSA and the CSA-B style preference ratios were internally consistent and; v) to see whether or not the CSA could be improved.

Specific hypotheses and a brief explanation for them are given below.

1. Due to the more subjective questions on the verbal-imagery dimension compared to the wholistic-analytic dimension it was expected that items on the verbal-imagery dimension would result in more errors than items on the wholistic-analytic dimension for both the CSA and the parallel version of the CSA-A (CSA-B).
2. Due to the difficulty in finding items that are exactly the same colour or type it was predicted that items that were classified as being the same type or colour on the verbal-imagery dimension would produce more errors than the items that were argued to be a different type or colour for both the CSA and the CSA-B.
3. Due to the practice effect it was predicted that fewer errors would be made as each successive test was taken.
4. Similarly, as a result of the practise effect it was also expected that faster reaction times would occur at session 2 and at retest.
5. It was expected that a parallel test could be created once suitable items for the verbal-imagery dimension had been piloted and matched with the verbal-imagery items from the CSA and appropriate wholistic-analytic items had been constructed using the same core geometric shapes as the CSA. Once the new verbal-imagery and wholistic-analytic items had been created for the parallel test it was expected that this parallel test would

result in similar reaction times and similar errors rates as Riding's original 1991 CSA test.

6. As a result of the careful matching of the original CSA items to the parallel items it was predicted that an individual's style preference ratio would be similar between the CSA and the CSA-B, stable over time and internally consistent.
7. Similarly, due to the matching of the items in the original and parallel test it was expected that an individual's style category allocation (which is based on the value of the style preference ratio) would remain the same between the CSA and the CSA-B, stable over time and internally consistent.
8. Finally, due to the more ambiguous questions on the verbal-imagery dimension than the wholistic-analytic dimension it was predicted that a person's place on the wholistic-analytic dimension (i.e., their wholistic-analytic ratio) would be more stable than their place on the verbal-imagery dimension (i.e., their verbal-imagery ratio).

Pre-Pilot Study: finding items for the Parallel Imagery CSA Test

A pre-pilot was carried out in an attempt to find a list of nouns that were clearly associated with one particular colour (e.g., coal is black, spinach is green) which could be used for the imagery section of the parallel version of the CSA.

3.3 Method

Eighteen psychology undergraduate students participated in this pre pilot study. All participants were given 38 novel colour associated nouns plus the 48 colour associated nouns used in Riding's (1991) CSA. Participants were asked to state what colour they thought each object was and to rate their confidence in their colour choice on a scale of 1-10 (10 being very confident, 0 unsure).

3.4 Results

The most frequently nominated word colour and the number of people who gave the colour a confidence rating of greater than seven is shown in Table 3.2 below (10 = High, 1 = Low). The majority of words that were associated with multiple colours were discarded from the potential word list. In addition, when confidence in the chosen word colour was low, (i.e., fewer than 10 people gave a confidence rating of greater than 7), the word was removed. For example, 'garlic' was nominated as white, yellow and purple and only 4/18 (22%) of the participants gave a confidence rating of greater than 7. Therefore, 'garlic' was not selected for the word list.

However, not all ambiguously coloured and low confidence ranked words were discarded. In order to match Riding's original colour words, which had to be kept, some words with low confidence ratings and colour ambiguity were retained. For example, only 4/18 (22%) of the subjects gave a confidence rating of 7 or above that Riding's word 'ice' was clear. Other colours suggested for 'ice' were white and blue. To match this ambiguity, the item 'water' was retained which was seen as clear by 6/18 (33%) of the subjects and was also nominated as blue, green and white.

In addition, words that had been associated with two colours were retained if the item with which they would later be mismatched was clearly different. For example, all participants perceived 'mustard' as either yellow or brown and it was later mismatched with 'mint' which all participants perceived as either white or green. As these colour choices were clearly different, it was argued to be an obvious mismatch and the items could be retained for the final list of possible words.

Table 3.2
Novel words and Riding's (1991) words, their nominated colour, and the number of people out of 18 who were more than 70% confident in their colour choice.

	Novel Colour Words				Riding's Original Colour Words		
	Word	Colour Chosen	No of Responses		Word	Colour Chosen	No of Responses
	Ketchup	Red	18		Chocolate	Brown	18
	Lips	Red	18		Coal	Black	18
	Milk	White/Cream	18		Grass	Green	18
	Banana	Yellow	17		Milk	White	18
	Broccoli	Green	17		Pea	Green	18
*	Cherry	Red	17		Tomato	Red	18
	Daffodil	Yellow	17		Blood	Red	17
*	Carrot	Orange	16		Chalk	White	17
	Hearse	Black	16	*	Postbox	Red	17
	Buttercup	Yellow	15		Strawberry	Red/Pink	17
	Marmite	Brown/Black	15		Tar	Black	17
	Bone	White	14		Canary	Yellow	16
	Cocoa	Brown	14	*	Custard	Yellow	16
	Coffee	Brown/Black	14		Leaf	Green	16
*	Pumpkin	Orange	14		Slate	Grey	16
	Fern	Green	13		Snow	White	16
*	Heart	Red	13		Flour	White	16
	Holly	Green	13		Lawn	Green	15
*	Panther	Black	13		Lettuce	Green	15
*	Coca Cola	Brown/Black	12		Mud	Brown	15
	Mandarine	Orange	12		Sun	Yellow	15
	Spinach	Green	12		Teeth	White	15
*	Coconut	White	11		Elephant	Grey	14
*	Corn	Yellow	11		Ivory	White/Cream	14
*	Mint	Green	11		Butter	Yellow	14
	Pig	Pink	11		Cucumber	Green	14
	Raspberry	Pink/Red	11		Salt	White	14
*	Steel	Silver/Grey	11		Gums	Red/Pink	13
*	Lead	Grey	10		Paper	White	13
*	Sapphire	Blue	10		Pavement	Grey	13
	Charcoal	Black	9		Plum	Purple	13
*	Pineapple	Yellow	9	*	Celery	Green	12
*	Window	Clear	9		Cream	White	12
*	Tangerine	Orange	8		Ivory	White/Cream	12
*	Diamond	Clear	6		Panda	Black/White	12
	Mustard	Yellow	6	*	Wood	Brown	12
*	Water	Clear	6	*	Cornflakes	Yellow	11
*	Garlic	White/Cream	4	*	Glass	Clear	11
				*	Smoke	Grey	11
				*	Heather	Purple	10
				*	Sea	Blue	10
				*	Brick	Red/Orange	9
				*	Flame	Orange/Red	9
				*	Oil	Black	9
				*	Omelette	Yellow	5
				*	Wheat	Yellow	4

* Items that were associated with more than one colour

Pilot Study: Comparing the new and old verbal and imagery items

A pilot study was conducted to compare participant responses and difficulty ratings to a sample of newly constructed verbal and imagery questions with Riding's original verbal and imagery questions.

3.5 Method

Fifty-two participants took part in the pilot study (35 women, 17 men: age range = 19-58; M = 23.04, SD = 7.99). The majority of the participants (81%) identified themselves as students at the University of Edinburgh, 13% were professional people and 6% did not identify an occupation.

Participants were given a survey that consisted of two sections (A and B). Section A contained 48 questions about comparing the colour of items (e.g., "Are Bone and Milk the same colour?"). Half of the items were taken from Riding's (1991) CSA test and the other half were matched novel items designed by the experimenter on the basis of the pre-pilot study. Participants were asked to indicate whether they thought the pair of items were the same colour or a different colour. Following completion of the section, participants were asked to put a tick beside any of the decisions that were difficult to make.

Section B contained 48 questions about comparing the conceptual category of the items (e.g., "Are Car and Van the same type?"). As in section A, half of the items were those used in Riding's (1991) CSA test and the other half were matched novel items designed by the experimenter. Participants were asked to state whether they thought the pair of items were from the same category type or a different category type. For clarity, an example of a category match and mismatch was given in the instructions. The example used was the same as that used in Riding's (1991) CSA. This example was "Ball and Tennis are not the same category because they are *not both* sports. Oak and Beech are the same category because they are *both* trees". Following completion of the section, participants were asked to indicate if any of the decisions were difficult to make.

To control for word order effects, the survey item order was randomised. Two versions with different item orders were created and distributed.

3.6 Results

Overall, the majority of novel colour word pairs (18/24), and almost all of the novel category pairs (23/24) were found to be a good match with Riding's (1991) CSA in terms of difficulty and correct identification. Therefore, these items were retained for the final parallel test version. The process and criteria for determining a good match are outlined below.

Item pairs were singled out where more than 5 people (10% of the participants) classified them differently to the hypothesised classification of Riding (1991) and the experimenter. For example 12 of the participants (23%) thought that beans and chicken were not the same type, possibly because a chicken is an animal and beans are vegetables. However, as noted above, in Riding's CSA, beans and chicken are classified as the same type because they are both food. Similarly, items that were marked as difficult by more than 10% of the subjects were also extracted for further examination. A list of these items, the number of people who found them difficult and the number of people whose categorisation of type or colour differed from those hypothesised can be found below in Tables 3.3-3.6.

All of Riding's (1991) items were retained. In order to create a parallel version of Riding's CSA, items of comparable difficulty and level of ambiguity were selected. This resulted in some of the items being removed or reformulated into easier or less ambiguous pairings. For example, the most ambiguous items on the parallel colour matching section of the CSA were 'Chocolate and Wood' and 'Ketchup and Lips' (see Table 3.3). These pairs were argued not to be the same colour by 43% and 31% of the participants respectively. In contrast, the most ambiguous colour pairing in the original CSA was 'Cream and Paper' where 37% of participants thought they were not the same colour. To balance this discrepancy, the 'Chocolate and Wood' pair was removed and replaced by 'Mandarin and Carrot', but the 'Ketchup and Lips' item was retained. However, in order to construct the 'Mandarin and Carrot' pair, two other pairs, 'Mud and Mandarin' and 'Carrot and Lion,' were broken up. This was necessary because it is harder to find a colour match than it is to find a colour mismatch due to the limited number of items that are associated with only one colour.

The original and parallel items were matched for difficulty in a similar way. Tables 3.3-3.6 indicate that it was the colour pairs that were found to be the most ambiguous and least difficult and the categorical type items that were the least ambiguous and most difficult. Overall, six changes were made to the novel colour item pairs and two item pairs were completely replaced. Only one alteration was made for the conceptual item pairs. A full account of what items were changed and the final list of items selected for the parallel version of the CSA can be found in Tables 3.7-3.9.

Table 3.3.

Colour item pairs that more than 10% of the participants identified differently (incorrectly) from Riding's (1991, 1998) CSA compared to the parallel form of the CSA.

Riding's (1991) CSA items	Incorrect	Parallel CSA items	Incorrect
Blood and Tomato	8	Broccoli and Holly	10
Bread and Butter	8	Chocolate and Wood	25
Canary and Sun	8	Coffee and Marmite	7
Chalk and Salt	6	Hearse and Soot	7
Cream and Paper	21	Ketchup and Lips	18
Ice and Glass	6	Strawberry and Tomato	8
Lettuce and Lawn	6	Window and Water	11
Omelette and Custard	11		
Postbox and Strawberry	7		
Snow and Flour	10		
No. of items	10	No. of items	7
Total no. incorrect	91	Total no. incorrect	86

Table 3.4.

Colour item pairs that more than 10% of the participants marked as difficult for Riding's (1991) CSA items compared to a parallel version of the CSA.

Riding's (1991) CSA items	Difficulty	Parallel CSA items	Difficulty
Ice and Glass	11	Window and Water	8
Omelette and Custard	6	Heart and Cherry	6
Panda and Heather	6	Bone and Milk	5
		Chocolate and Wood	6
		Lion and Carrot	6
		Pig and Butter	5
No. of items	3	No. of items	6
Total of difficulty	23	Total of difficulty	36

Table 3.5.
Categorical item pairs that more than 10% of the participants identified differently (incorrectly) from that hypothesised by Riding's (1991) CSA compared to a parallel version of the CSA.

Riding's (1991) CSA items	Incorrect	Parallel CSA items	Incorrect
Beans and Chicken	12	Apple and Bread	10
Cook and Teacher	9	Doctor and Teacher	6
Curtain and Rug	8	Jam and Ham	8
Cycling and Skating	10	Pork and Tomato	12
Fork and Spade	11	Elephant and Mouse	10
Trout and Angling	8		
No. of items	6	No. of items	5
Total no. incorrect	58	Total no. incorrect	46

Table 3.6
Categorical item pairs that more than 10% of participants identified as difficult for Riding's (1991) CSA items compared to a parallel version of the CSA.

Riding's (1991) CSA items	Difficulty	Parallel CSA items	Difficulty
Cook and Teacher	5	Apple and Bread	5
Curtain and Rug	5	Horse and Cart	7
Fisherman and Herring	5	Book and Worm	6
Fork and Spade	10	Dog and Lead	5
Manager and Football	10	Breakfast and Bed	6
Mug and Coffee	5	Gold and Teeth	6
Nurse and Bed	5	Jam and Ham	7
Snooker and Table	8	Pencil and Newspaper	5
Trout and Angling	7	Table and Tree	7
No. of items	9	No. of items	9
Total of difficulty	60	Total of difficulty	54

Table 3.7
Shows the original colour word pairs used in Riding's (1991) CSA, novel parallel category items selected for the pilot, and the items that were changed for the final parallel test version.

Original CSA Colour Word Pairs		Parallel Colour Items Selected for the Pilot
Mud and Chocolate		Hearse and Soot
Omelette and Custard		Bone and Milk
Grass and Oil		Hearse and Snow
Lettuce and Lawn	*	Chocolate and Wood
Cornflakes and Milk		Heart and Cherry
Smoke and Flame	*	Custard and Postbox
Bread and Butter		Coca-Cola and Ice
Panda and Heather		Coffee and Marmite
Cream and Paper		Custard and Cocoa
Snow and Flour		Pea and Gorilla
Ice and Glass	*	Lion and Carrot
Leaf and Cucumber		Daffodil and Lemon
Elephant and Ivory	*	Broccoli and Holly
Brick and Ivory		Strawberry and Tomato
Canary and Sun		Fern and Spinach
Pea and Pavement		Elephant and Raspberry
Blood and Tomato		Pig and Butter
Wood and Sea		Banana and Buttercup
Postbox and Strawberry		Lion and Lettuce
Chalk and Salt		Mint and Mustard
Tar and Coal	*	Mud and Mandarin
Teeth and Gums		Ketchup and Lips
Slate and Celery		Window and Water
Plum and Wheat	*	Pumpkin and Flour

* Item changed for the final version

Explanation of changes to Table 3.7

'Chocolate and Wood' was removed and replaced with 'Parsley and Grass'.
'Custard and Postbox' was removed as 'Custard' was already being used.
'Lion and Carrot' was removed because 'Lion' was already being used. It was replaced with 'Concrete and Postbox'.
'Broccoli and Holly' became 'Broccoli and Pumpkin'.
'Mud and Mandarin' became 'Mud and Blood' because 'Mandarin' was used to match with 'Carrot'.
'Pumpkin and Flour' became 'Holly and Flour'.
'Grass and Snow' became 'Charcoal and Snow' because 'Grass' was used to match with 'Parsley'
'Mandarine and Carrot' was added to create and equal number of similar and different items.

Table 3.8
Shows the original category word pairs used in Riding's (1991) CSA, novel parallel category items selected for the pilot, and the items that were changed for the final parallel test version.

Original CSA Categorical Word Pairs	Parallel Categorical Items Selected for the Pilot	
Netball and Swimming	Apple and Bread	
Bacon and Lawyer	Bus and Bear	
Curtain and Rug	Knife and Spoon	
Snooker and Table	Gold and Teeth	
Trout and Angling	Book and Worm	
Golf and Teapot	Table and Tree	
Hockey and Soldier	Pork and Tomato	
Fisherman and Hearing	Running and Swimming	
Onion and Potato	Jam and Ham	
Cycling and Skating	Elephant and Mouse	
Mug and Coffee	Pencil and Newspaper	
Beans and Chicken	Dog and Lead	
Fireplace and Chips	Cleaner and Bath	
Manager and Football	Aunt and Niece	
Secretary and Salesman	Baby and Infant	
Doctor and Sailing	Computer and Cat	
Car and Van	Doctor and Teacher	
Nurse and Bed	Bread and Breakfast	
Cook and Teacher	Horse and Cart	
Engineer and Clerk	Architect and Plate	
Rice and Cheese	Architect and Plate	*
Skiing and Cricket	Journalist and Accountant	
Fork and Spade	Mother and Music	
Chair and Gravy	Badminton and Cricket	

* Item exchanged for 'Cross Road and Puzzle' due to 'Architect and Plate' being used twice by mistake.

Table 3.9.
Final selection of word pairs for the parallel version of Riding's (1991) CSA (called the CSA-B).

Colour Pairs	Categorical Pairs
Banana and Buttercup	Apple and Bread
Bone and Milk	Bus and Bear
Parsley and Grass	Knife and Spoon
Concrete and Postbox	Gold and Teeth
Coca-Cola and Ice	Book and Worm
Coffee and Marmite	Table and Tree
Custard and Cocoa	Pork and Tomato
Custard and Postbox	Running and Swimming
Daffodil and Lemon	Jam and Ham
Elephant and Raspberry	Elephant and Mouse
Fern and Spinach	Pencil and Newspaper
Charcoal and Snow	Dog and Lead
Hearse and Soot	Cleaner and Bath
Heart and Cherry	Aunt and Niece
Ketchup and Lips	Baby and Infant
Mandarin and Carrot	Computer and Cat
Lion and Lettuce	Doctor and Teacher
Mint and Mustard	Bread and Breakfast
Mud and Blood	Horse and Cart
Pea and Gorilla	Architect and Plate
Pig and Butter	Cross Road and Puzzle
Holly and Flour	Journalist and Accountant
Strawberry and Tomato	Mother and Music
Window and Water	Badminton and Cricket

The Reliability of the CSA and the Parallel version of the CSA

Once the verbal-imagery items for the parallel version of the CSA had been tested and finalised, the wholistic-analytic items for the parallel version of the CSA were designed and constructed (more detail is given below). Due to the less ambiguous nature of the wholistic-analytic test, the new items for the parallel CSA were not piloted. Once all the items had been created, the parallel version of the CSA was assembled using the same basic design and structure as Riding's original CSA.

This study investigated the test-retest reliability of the original CSA (referred to from now on as the CSA-A) and the newly assembled parallel form called the CSA-B.

3.7 Method

3.7.1 Participants

Participants in the study were 14 males and 36 females (age range 18-59; M = 27.6, SD = 11.4). The majority of the participants were undergraduate students at the University of Edinburgh and all spoke English as their first language. Participants were recruited through tutorial groups, halls of residence and by word of mouth. The majority of participants (45) were right handed, four were left-handed and one was ambidextrous. The average level of education was high (education range = 10-24 years M = 16.9, SD = 2.9).

3.7.2 Apparatus

Two E-PRIME computer programs were created by the author to present, control and record the temporal parameters of the two tasks. E-PRIME is a computer software package designed to assist in the generation of computer based experiments (see www.pstnet.com/e-prime/default.htm). This experiment was designed on a Beta version of the product. Task one was an exact replica of Riding's (1991) Cognitive Styles Analysis test (CSA-A). The only difference between the original CSA and the CSA-A is that the CSA presents a summary of the results on task completion but this was removed on the CSA-A, so that the subjects are ignorant as to their imputed cognitive style at retest. All other screen presentations were exactly the same in terms of colour, font, style and timing. Task two (CSA-B) was designed to be a parallel version of Riding's CSA. The tasks were presented on a Fujitsu Pentium laptop.

3.7.3 Stimulus materials

The stimuli for both the CSA-A and the CSA-B were grouped into two categories; verbal-imagery stimuli, and wholistic-analytic stimuli.

Verbal-imagery stimuli

The verbal-imagery stimuli consisted of 48 verbal statements divided into two subsets. The first subset consisted of 24 statements that required participants to compare the colour of two objects e.g., "Are Blood and Tomato are the same colour?". The second subset consisted of 24 statements that required participants to conceptually compare two objects e.g., "Are Car and Van are the same type?". Twelve of the statements in each subset were true and 12 were false.

The verbal-imagery stimuli used in the CSA-A were exactly the same as Riding's original CSA (see Table 3.7 and 3.8). The verbal-imagery stimuli employed in the CSA-B were chosen on the basis of the pre-pilot and the pilot study described above, which matched items for difficulty and similarity with Riding's (1991) original CSA (see Table 3.9).

Wholistic-analytic stimuli

The wholistic stimuli consisted of 20 pairs of complex geometric figures. The geometric figures consisted of a combination of three of the following shapes: square, rectangle, right-angled triangle, hexagon, cross, and an L shape. Half of the pairs were identical pairs, the other half were not identical. Each stimulus item asked the question "Is shape X the same as shape Y?" (e.g., see Figure 2.1).

The analytic stimuli included the presentation of 20 single geometric shapes next to a complex geometric figure that consisted of three geometric shapes. Half of the single geometric shapes were also contained within the neighbouring complex geometric shape, the other half were not contained within the complex shape. Each item was framed with the question "Is shape X contained in shape Y?" (e.g., see Figure 2.2).

The wholistic-analytic stimuli used in the CSA-A were exactly the same as Riding's original CSA test. The CSA-B's wholistic and analytic stimuli were created using a Unix computer program (Allerhand, 2000). The same core geometric shapes that were used in Riding's (1991) CSA were also used in the CSA-B. The only exception was that the CSA-B did not employ an L shape.

3.7.4 Design

In studying the reliability of a psychological measure it is appropriate to power the study to detect coefficients in excess of about .5. Coefficients below that would indicate poor reliability. Thus with alpha set at .05 (2 tailed) and with $r = .5$, this study had a power of .96. Adequate Power is usually considered to be 80 % or above. Indeed, the study had 82% power to detect an effect size (r) of .4.

A 2 x 2 x 2 (test version, session, order) mixed model analysis of variance (anova) was performed on the subjects' mean and median response times on each test section (verbal, imagery, wholistic, and analytic). Test version (CSA-A, CSA-B), and session (1, 2) were within subjects variables and test order (CSA-A-CSA-B, CSA-B-CSA-A) was a between subjects variable. Irrespective of whether the dependent variable was the mean or the median reaction time, the results were largely the same. The data were also log transformed, to adjust for a positive skew on each section of the test, and the anovas were recalculated, producing similar results. Only the anova results from the untransformed mean data will be discussed. An alpha level of .05 was used for all statistical tests.

The order of stimuli presentation in the CSA-A was the same as that used in Riding's (1991) CSA. The order of stimuli presentation in CSA-B maintained the same alternating sequence of verbal and imagery items that was used in the CSA-A and the order of correct and incorrect answers was also kept the same between the two tests. The wholistic-analytic dimension stimuli also maintained the same order of correct and incorrect responses as the CSA-A.

The presentation of CSA-A and CSA-B was counterbalanced across all participants to prevent differential practice effects between tasks. In addition, participants who sat the CSA-A first on their initial session were then given the CSA-B first on their second session and vice versa if they sat the CSA-B first on the first session.

3.7.5 Procedure

Participants were tested individually in a quiet room. Participants were first asked to give their age, gender, handedness and number of years of formal education. Following this, the experimental session proper began.

Participants were told that the experiment was not a test of intelligence or ability, but was designed to assess their cognitive style. Participants were then shown the two computer keyboard response keys (the "." and "/" keys on a normal keyboard) which were marked with blue and red stickers respectively. Participants were told that the blue key corresponded to a "No" response and that the red key corresponded to a "Yes" response. They were told that a message would be presented on the screen to remind them of this distinction. These response keys and colours were the same as Riding's original 1991 CSA test.

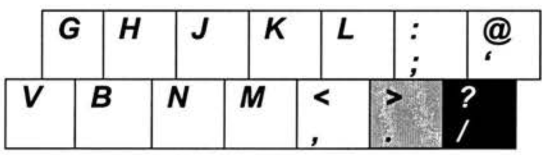


Figure 3.1.
Extract of a standard QWERTY keyboard, showing the location of the response keys where signifies blue and signifies red.

They were then told that a set of instructions would appear on the computer screen telling them what to do at each stage of the test. Participants were told to work at their own rate and that it was important to work continuously without interruption.

Stimulus materials were presented visually to participants. Prior to the onset of the verbal-imagery, wholistic and analytic sections of the test, the participants were presented with written instructions on the computer, which explained how they should respond. Worked examples were given only for the categorical items in the verbal-imagery dimension. In both tasks, the CSA-A and the CSA-B, the verbal-imagery stimuli were presented first, followed by the wholistic stimuli and then the analytic stimuli.

A session involved completing both the CSA-A and the CSA-B. Subjects had up to 10 seconds to respond to each stimulus. The next stimulus appeared only after a response had been made or 10 seconds had elapsed with no response. Reaction time and accuracy was recorded for each stimulus item.

Finally, participants were told that when the experiment finished the computer would say 'Thank you and Good-bye' and this was their cue to notify the experimenter that they had finished the first task (i.e., either the CSA-A or the CSA-B). All participants repeated the CSA-A and the CSA-B no less than 6 days later.

3.8 Results

Responses to each stimulus were classified as either correct or incorrect. Failure to respond within 10 seconds of the presentation of the stimulus was classified as an incorrect. Scores (total correct) and reaction times (ms) were recorded for each participant on each version (CSA-A, CSA-B), section (verbal, imagery, wholistic, analytic) and session (1,2).

3.8.1 Similarity between the responses on the CSA-A and the CSA-B

The CSA-A and the CSA-B had similar mean and median reaction times and similar standard deviations within each test section and session (see Table 3.10). In keeping with previous research, reaction times decreased with practice, resulting in faster reaction times and smaller standard deviations at session 2 for all sections of both tests and faster reaction times and smaller standard deviations with each successive test (i.e., the verbal section was administered first and the analytic section last). In addition, each subject seemed to perform at a slightly different speed on each section of the test irrespective of the version or session (see Appendix 1).

No subjects got more than 30% of the items incorrect on any one section of the test. Therefore, it can be assumed that all the subjects understood the task instructions and approached the task conscientiously (Riding, 1998).

Overall error rates were found to be low, with 97% of responses on the CSA-A and 96% of the response on the CSA-B being correct. The mean number of errors for each version of the test, section of the test and each testing session are reported in Table 3.11 below. As expected, the number of errors made decreases at retest (session 2). However, the total number of items that resulted in error appeared to remain fairly constant between the CSA-A and the CSA-B. Items that had an error rate of higher than 10% are listed separately in Table 3.12 along with the number of times the error was made. With the exception of two analytic items, all items that had an error rate of greater than 10% were from the verbal-imagery section of both the CSA-A and the CSA-B. In addition, almost all of the common errors that were made on the verbal and imagery sections of the CSA-A and the CSA-B were also incorrectly identified by more than 10% of the subjects in the pilot study (for comparison see Tables 3.3-3.6).

Table 3.10
Table of means, medians and standard deviations of reaction times for each version of the test (CSA-A, CSA-B) for each section of the test (verbal, imagery, wholistic and analytic) and for each session (1 and 2). All units are in milliseconds.

Test	Session	Verbal	Imagery	Wholistic	Analytic
CSA-A	1	M = 2622.1 MD = 2272.5 D = 1318.8	M = 2591.8 MD = 2303.5 SD = 1211.7	M = 2078.7 MD = 1619.5 SD = 1430.6	M = 1673.5 MD = 1456.5 SD = 846.1
	2	M = 2109.5 MD = 1863.5 SD = 973.4	M = 2050.7 MD = 1855.5 SD = 873.9	M = 1619.8 MD = 1312.5 SD = 985.6	M = 1386.3 MD = 1170.5 SD = 690.4
CSA- B	1	M = 2722.6 MD = 2376.0 SD = 1361.2	M = 2688.3 MD = 2371.5 SD = 1324.6	M = 2139.8 MD = 1683.0 SD = 1344.5	M = 1677.5 MD = 1356.5 SD = 957.6
	2	M = 2127.2 MD = 1883.0 SD = 961.7	M = 2088.3 MD = 1894.0 SD = 875.1	M = 1642.2 MD = 1369.0 SD = 864.3	M = 1408.3 MD = 1206.5 SD = 683.6

Table 3.11
Total number of errors, the number of items that caused an error, and the percentage of errors out of the total number of items for each version of the test (CSA-A, CSA-B) each section of the test (verbal, imagery, wholistic, analytic) and each session (1, 2).

Test	Session	Verbal	%	Imager	%	Wholistic	%	Analytic	%	Total	%
CSA-A	S1 Errors	N = 57	5%	N = 46	4%	N = 14	1%	N = 39	4%	N = 156	3%
	No of Items	N = 16	66%	N = 13	54%	N = 6	30%	N = 15	75%	N = 50	57%
	S2 Errors	N = 44	4%	N = 42	4%	N = 13	1%	N = 23	2%	N = 122	3%
	No of Items	N = 15	63%	N = 166	6%	N = 8	40%	N = 11	55%	N = 50	57%
	Total No Errors	N = 101	4%	N = 88	3%	N = 27	1%	N = 62	3%	N = 278	3%
	Total No of Items	N = 19	40%	N = 19	40%	N = 14	35%	N = 26	65%	N = 78	44%
CSA- B	S1 Errors	N = 92	8%	N = 48	4%	N = 23	2%	N = 32	3%	N = 195	1%
	No of Items	N = 18	75%	N = 16	67%	N = 11	70%	N = 14	70%	N = 59	67%
	S2 Errors	N = 59	5%	N = 29	2%	N = 18	2%	N = 19	2%	N = 125	3%
	No of Items	N = 13	54%	N = 16	67%	N = 10	50%	N = 9	45%	N = 48	54%
	Total No Errors	N = 151	6%	N = 77	3%	N = 41	2%	N = 51	3%	N = 320	4%
	Total no of Items	N = 20	42%	N = 19	40%	N = 21	53%	N = 24	60%	N = 84	48%

Table 3.12
Items on the CSA-A and CSA-B that were incorrect more than a total of 10% of the time are shown along with the number of times the error was made on each section (verbal, imagery, wholistic, analytic) and session (1, 2). The total number of errors on each item for each section and session is also shown. Where applicable the correct answer is shown in brackets (Y = Yes, N = No)

Item	No. Errors at Session 1	No. Errors at Session 2	Total No of Errors
CSA- A Verbal			
Beans and Chicken are the same Type (Y)	12	8	20
Cook and Teacher are the same Type (Y)	9	5	14
Rice and Cheese are the same Type(Y)	6	5	11
CSA-B Verbal			
Apple and Bread are the same Type (Y)	10	9	19
Crossroad and Puzzle are the same Type (N)	8	9	17
Elephant and Mouse are the same Type (Y)	11	5	16
Jam and Ham are the same Type (Y)	13	6	19
Pork and Tomato are the same Type (Y)	21	13	34
CSA-A Imagery			
Bread and Butter are the same Colour (N)	2	10	12
Cream and Paper are the same Colour (Y)	8	4	12
Lettuce and Lawn are the same Colour (Y)	9	4	13
CSA-B Imagery			
Hearse and Soot are the same Colour (Y)	9	4	13
CSA-A Analytic			
Item 2	9	7	16
CSA-B Analytic			
Item 3	7	5	12

Significant differences in subjects' reaction times between test items answered correctly and incorrectly were found for the verbal section of the test, t (265) = 4.59, p < .001 and the imagery section of the test, t (167) = -3.52, p = .001. In both cases, the items that were answered correctly corresponded to faster reaction times. No significant differences were found between the reaction times on the correct and incorrect items on the wholistic or analytic sections of the tests.

Correlations between the speed of response and the total number of errors made by each subject at each session is shown in Table 3.13 below. There appears to be no speed-accuracy trade-off with the correlations grouping around 0.

Items that were classified as being the same colour (e.g., bone and milk) or the same category (e.g., cook and teacher) resulted in slower reaction times than items that were classified as being different colours (e.g., teeth and gums) or different categories (e.g., golf and teapot), but none of these differences were significant (see Table 3.14).

Items categorised as being similar resulted in significantly more errors than those classified as different, except on the imagery section of the CSA-A, where the difference was not significant (see Table 3.14).

A 2 x 2 x 2 (test version, session, order) mixed model of analysis of variance (anova) was performed on the subjects' mean and median response times on each section of the test (verbal, imagery, wholistic, analytic). The results are shown in Table 3.15. Irrespective of whether the dependent variable was the mean or median, the results were largely the same. anova's were also carried out on the logs of the mean and median response times producing similar results. Examples of transformed data can be found in appendix 1.

Main effects were found for the experiment version (CSA-A, CSA-B) in the verbal (F [1, 48] = 4.21, p = .046) and imagery sections (F [1, 48] = 5.32, p = .025). These effects reflect the slightly faster CSA-A verbal and CSA-A imagery response times compared to the CSA-B. A main effect was also found for session on each test section (all p's < .001), with performance at session 2 being faster than performance at session 1.

Significant interactions were found between test version (CSA-A, CSA-B) and the order of the test's presentation (i.e., CSA-A-CSA-B or CSA-B- CSA-A) (all p's <.001). This interaction reflected the fact that the test taken second resulted in the faster response times irrespective of the order. Similarly, a three-way interaction was also found between the experiment, session and order for each section of the test (all p's < .001). This also appears to have resulted from a practice effect.

Table 3.13
Correlations and their respective p values between the total number of errors made by each subject and their reaction time for each section of the test (verbal, imagery, wholistic, analytic) and each session (1, 2).

	r_s	p value
Verbal, Session 1	.241	.093
Verbal Session 2	-.039	.789
Imagery Session 1	.049	.733
Imagery Session 2	.115	.427
Wholistic Session 1	-.252	.078
Wholistic Session 2	.224	.117
Analytic Session 1	.101	.485
Analytic Session 2	-.134	.354

Table 3.14
Number of errors made and the mean reaction times (ms) for items which are categorised as similar or different on the CSA-A and the CSA-B for the verbal and imagery sections. The differences between the no of errors on similar and different items and the difference between the mean reaction time (ms) on similar and different items are also given.

Test Version	Section	Item	No of errors	Binomial p value	Mean RT of RT	Standard Deviation	t-test for difference in RT (unequal variance assumed)
CSA-A	Verbal	Same	74		2695	1548	
		Different	27	.000	2645	1486	t(47) = .145, p = .885
	Imagery	Same	48		2644	2124	
		Different	40	.456	2573	1625	t(85) = .178, p = .860
CSA-B	Verbal	Same	108		2893	1653	
		Different	43	.001	3136	1830	t(70) = -.758, p = .451
	Imagery	Same	54		3259	1684	
		Different	23	.000	2843	2170	t(33) = .820, p = .418

Table 3.15
The p value and eta squared (given in brackets) for the main effects and interactions for experimental version, session and order of tests, for subjects' mean and median reaction time (ms) and logged mean reaction time (ms), median reaction time (ms) and log-logged median reaction time (ms) on each section of the test (verbal, imagery, wholistic, and analytic).

	Version (CSA-A, CSA-B)	Session (1 vs 2)	Order CSA-A-B CSA-B-A	Version x Session	Version x Order	Session x Order	Version x Session x Order
Verbal							
Mean	.046 (.08)	.000 (.69)	.200 (.03)	.028 (.10)	.000 (.33)	.978 (.00)	.000 (.67)
Median	.014 (.12)	.000 (.68)	.210 (.03)	.010 (.13)	.000 (.32)	.718 (.00)	.000 (.68)
Log of Mean	.034 (.09)	.000 (.73)	.207 (.03)	.033 (.09)	.000 (.31)	.574 (.00)	.000 (.67)
Log of Median	.024 (.10)	.000 (.74)	.234 (.03)	.019 (.11)	.000 (.24)	.640 (.00)	.000 (.71)
Log log of Mean	.034 (.09)	.000 (.73)	.207 (.03)	.033 (.09)	.000 (.31)	.574 (.01)	.000 (.69)
Imagery							
Mean	.025 (.10)	.000 (.74)	.159 (.04)	.087 (.06)	.000 (.33)	.043 (.08)	.000 (.60)
Median	.014 (.12)	.000 (.74)	.162 (.01)	.030 (.10)	.000 (.32)	.013 (.12)	.000 (.62)
Log of Mean	.055 (.08)	.000 (.71)	.172 (.04)	.248 (.03)	.000 (.30)	.090 (.06)	.000 (.61)
Log of Median	.075 (.07)	.000 (.78)	.180 (.03)	.150 (.04)	.000 (.23)	.036 (.09)	.000 (.62)
Log log of Mean	.055 (.08)	.000 (.77)	.172 (.04)	.248 (.03)	.000 (.30)	.090 (.06)	.000 (.61)
Wholistic							
Mean	.175 (.04)	.000 (.55)	.061 (.07)	.147 (.04)	.000 (.35)	.652 (.00)	.000 (.62)
Median	.260 (.03)	.000 (.51)	.093 (.06)	.488 (.01)	.000 (.26)	.547 (.00)	.000 (.51)
Log of Mean	.045 (.08)	.000 (.63)	.061 (.07)	.109 (.05)	.000 (.34)	.833 (.00)	.000 (.69)
Log of Median	.038 (.09)	.000 (.61)	.091 (.06)	.538 (.01)	.000 (.25)	.745 (.00)	.000 (.58)
Log log of Mean	.020 (.11)	.000 (.65)	.065 (.07)	.114 (.05)	.000 (.31)	.975 (.00)	.000 (.70)

table continues

Table 3.15 continued

	Version (CSA-A, CSA-B)	Session (1 vs 2)	Order CSA-A-B CSA-B-A	Version x Session	Version x Order	Session x Order	Version x Session x Order
Analytic							
Mean	.362 (.02)	.000 (.63)	.108 (.05)	.628 (.00)	.000 (.27)	.614 (.00)	.000 (.50)
Median	.958 (.00)	.000 (.58)	.121 (.05)	.302 (.02)	.001 (.20)	.289 (.02)	.000 (.29)
Log of Mean	.341 (.02)	.000 (.70)	.115 (.05)	.901 (.00)	.000 (.25)	.753 (.00)	.000 (.52)
Log of Median	.795 (.00)	.000 (.69)	.137 (.05)	.160 (.04)	.001 (.20)	.992 (.00)	.000 (.33)
Log log of Mean	.308 (.02)	.000 (.72)	.118 (.05)	.926 (.00)	.000 (.24)	.416 (.01)	.000 (.53)

The only effect that appears not clearly explicable is a weak but significant interaction between version and session for the verbal section of the test. No other significant interactions were found.

Overall, these results indicate that the CSA-A and the CSA-B have similar reaction times, error rates and thus behave in similar ways. Therefore, the CSA-B may be treated as a suitable parallel test for the CSA-A.

3.8.2 Allocation of cognitive style

Riding's CSA determines a person's cognitive style by using a three-step formula. Step 1: Calculate the average response time on each section of the CSA (verbal, imagery, wholistic and analytic). Step 2: Calculate two ratios: the first between the average reaction times on the verbal and imagery items and the second between the average reaction times on the wholistic and analytic items. Step 3: Associate the value of each subject's verbal-imagery ratio and wholistic-analytic ratio with a style category. Note that Riding (1998) suggests that research groups can allocate style category in two main ways: (i) divide the sample into three groups on each dimension or (ii) compare the ratios with a standardised sample comprising of 999 people in the UK (see Table 3.1) (Riding, 1998a).

3.8.3 Stability of the CSA-A and CSA-B

In order to examine how reliable and stable this procedure of style allocation was, correlations between each subject's performance on the two test versions (CSA-A, CSA-B) and two sessions (1, 2) at each of the three steps were calculated. Kline (2000) suggested that a reliability of about .7 is the minimum requirement for a good test and a test re-test period of 4 weeks is recommended.

Table 3.16 shows that the correlations at step 1 between each subject's median reaction times on each version of the test (i.e., between the CSA-A and the CSA-B) were high (Mean $\underline{r}$ = .72; Range $\underline{r}$ = .55 to $\underline{r}$ = .87). It was therefore concluded that the initial reaction times were reliable and stable between the original and parallel versions of the test. Correlations between the median reaction times on each session (i.e., between session 1 and session 2) of the test were also high (Mean $\underline{r}$ = .72; Range $\underline{r}$ = .61 to $\underline{r}$ = .86), suggesting that initial individual differences in reaction times on the CSA-A and the CSA-B are stable over time.

Table 3.16
Pearson's correlations between the median reaction times in ms for each test version (CSA-A and CSA-B) for each section of the test (verbal, imagery, wholistic and analytic) and for each session (1 and 2). Items in bold are show the correlations within the same test section. Items underlined show the correlations within the same test.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	CSA-A, Verbal, S1																
2	CSA-A, Verbal, S2	**.611**															
3	CSA-B, Verbal, S1	**.581**	**.800**														
4	CSA-B, Verbal, S2	**.733**	**.766**	**.712**													
5	CSA-A, Imagery, S1	.845	.845	.653	.649												
6	CSA-A, Imagery, S2	.618	.938	.823	.812	**.705**											
7	CSA-B, Imagery, S1	.504	.773	.914	.659	**.623**	**.819**										
8	CSA-B, Imagery, S2	.765	.694	.665	.917	**.812**	**.779**	**.624**									
9	CSA-A, Wholist, S1	.711	.546	.500	.621	.744	.516	.5098	.616								
10	CSA-A, Wholist, S2	.537	.670	.721	.625	.608	.625	.749	.561	**.731**							
11	CSA-B, Wholist, S1	.365	.618	.778	.490	.447	.544	.747	.412	**.546**	**.784**						
12	CSA-B, Wholist, S2	.572	.619	.723	.752	.618	.658	.709	.691	**.696**	**.866**	**.735**					
13	CSA-A, Analytic, S1	.625	.532	.549	.595	.701	.504	.552	.594	.826	.800	.702	.788				
14	CSA-A, Analytic, S2	.609	.686	.690	.749	.638	.708	.706	.679	.705	.871	.695	.886	**.817**			
15	CSA-B, Analytic, S1	.446	.627	.802	.608	.501	.604	.740	.513	.548	.824	.896	.803	**.710**	**.798**		
16	CSA-B, Analytic, S2	.501	.656	.663	.684	.561	.638	.670	.620	.695	.841	.742	.871	**.818**	**.873**	**.861**	

All results were significant at the $p < 0.01$ level

The correlations between test versions and sessions for the verbal-imagery and wholistic-analytic ratios at step 2 and labels at step 3 were computed next (see Tables 3.17 - 3.19). These correlations were found to be low, with the wholistic-analytic dimension correlations around r = .2 or r = .3. The verbal-imagery ratios were lower around the r = .1 or r = .2 level.

A closer analysis of the step 3 correlations between the style categories showed that 66% of the participants changed style category at retest on the CSA-A's verbal-imagery dimension and 60% changed on the CSA-B's verbal-imagery dimension (the degree of agreement [Kendall's tau] for the verbal-imagery dimension was .005, p = .875). On the wholistic-analytic dimension, 50 % of subjects on the CSA-A and 46 % of the subjects on the CSA-B changed style categories at retest (the degree of concordance was .081, p = .007) (see Tables 3.20a-d).

Note also that the correlations at steps 2 and 3, between the CSA-A and CSA-B ratios and style labels, were low despite the fact that the participants in the study represented a full range of cognitive styles at both session 1 and session 2 (see Table 3.21). Furthermore, the mean of this study's style ratios for each dimension (verbal-imagery M = 1.0, SD = .20, wholistic-analytic M = 1.2, SD = .33) were also found to be similar to Riding's Secondary School Standardisation Sample (verbal-imagery M = 1.1, SD = .20, wholistic-analytic M = 1.3, SD = .45). Therefore, this study contained a full and representative range of individual differences in the way subjects responded to the verbal-imagery and wholistic-analytic dimensions, but these differences were not stable.

In summary, the CSA-A and CSA-B results show that initial reaction times are stable and reliable but the style ratios and style labels have low parallel-form and test-retest reliabilities (see Table 3.22 for an overview of these results). The wholistic-analytic ratio did remain more stable than the verbal-imagery ratio, but it was still below acceptable levels for a psychometric test, especially one that is meant to measure something which is thought to be innate and fixed (Riding & Rayner, 1998).

Table 3.17
Pearson's correlations between the style ratios for the CSA-A and the CSA-B for each section of the test (verbal, imagery, wholistic, analytic) and for each session (S1, S2), p values are given in brackets. Items in bold show the correlations within the same style dimension. Items underlined show the correlations within the same test.

		1	2	3	4	5	6	7
1	CSA-A, Verbal-Imagery dimension, S1							
2	CSA-A, Verbal-Imagery dimension, S2	**.201** (.161)						
3	CSA-B, Verbal-Imagery dimension, S1	**.175** **(.223)**	**.105** **(.446)**					
4	CSA-B, Verbal-Imagery dimension, S2	**-.006** (.968)	**.358** (.011)	.202 (.159)				
5	CSA-A, Wholistic Analytic dimension, S1	.116 (.421)	.055 (.703)	.026 (.855)	-.039 (.789)			
6	CSA-A, Wholistic Analytic dimension, S2	-.189 (.189)	.045 (.754)	-.077 (.597)	.023 (.877)	**.297** **(.036)**		
7	CSA-B, Wholistic Analytic dimension, S1	-.159 (.207)	.183 (.205)	-.188 (.192)	.027 (.851)	**.074** **(.609)**	**.293** **(.039)**	
8	CSA-B, Wholistic Analytic dimension, S2	.082 (.572)	-.309 (.029)	.118 (.414)	-.004 (.979)	**.250** **(.079)**	**.301** **(.034)**	.310 .(028)

Table 3.18
The degree of relationship (Kendall's Tau) between the verbal-imagery style dimension categories. Items underlined show the correlations within the same test. All p values are given in brackets.

		1	2	3
1	CSA-A, Verbal- Imagery dimension, S1			
2	CSA-A, Verbal-Imagery dimension, S2	<u>.100</u> (.437)		
3.	CSA-B, Verbal-Imagery dimension, S1	.139 (.227)	.110 (.391)	
4	CSA-B, Verbal-Imagery dimension, S2	.034 (.788)	.256* (.046)	<u>.145</u> (.254)

* = significant

Table 3.19
The degree of relationship (Kendall's Tau) between the wholistic-analytic style dimension categories. Items underlined show the correlations within the same test. All p values are given in brackets.

		1	2	3
1.	CSA-A, Wholistic-Analytic dimension, S1			
2	CSA-A, Wholistic-Analytic dimension, S2	<u>.341</u> (.017)		
3	CSA-B, Wholistic-Analytic dimension, S1	.146 (.304)	.088 (.534)	
4	CSA-B, Wholistic-Analytic dimension, S2	.314 (.023)	.301 (.034)	<u>.225</u> (.110)

Table 3.20 a
The number of times subjects were allocated to each style category on the verbal-imagery dimension on the CSA-A at Session 1 and Session 2. Items in bold show the number of times the subject was allocated to the same category within each test.

CSA-A Session 2		Verbal	Bimodal	Imagery
CSA- A Session 1	Verbal	**8**	9	4
	Bimodal	5	**5**	2
	Imagery	4	9	**4**

Table 3.20 c
The number of times subjects were allocated to each style category on the wholistic-analytic style dimension on the CSA-A at session 1 and session 2. Items in bold show the number of times the subject was allocated to the same category within each test.

CSA-A Session 2		Analytic	Intermediate	Wholistic
CSA-A Session 1	Analytic	**7**	7	0
	Intermediate	7	**16**	4
	Wholistic	1	6	**2**

Table 3.20 b.
The number of times subjects were allocated to each style category on the verbal-imagery dimension on the CSA-B at Session 1 and Session 2. Items in bold show the number of times the subject was allocated to the same category within each test.

CSA-B Session 2		Verbal	Bimodal	Imagery
CSA- B Session 1	Verbal	**8**	7	3
	Bimodal	7	**6**	4
	Imagery	5	4	**6**

Table 3.20 d.
The number of times subjects were allocated to each style category on wholistic-analytic dimension on the CSA-B at session 1 and session 2. Items in bold show the number of times the subject was allocated to the same category within each test.

CSA-B Session 2		Analytic	Intermediate	Wholistic
CSA-B Session 1	Analytic	**3**	2	0
	Intermediate	7	**21**	3
	Wholistic	3	8	**3**

Table 3.21
Table of style label frequency at session 1 and session 2 based on Riding's (1998a) standardised norms.

Dimension	Session 1 Frequency	Session 2 Frequency
Verbal Imagery Dimension		
Verbal	39	37
Bimodal	29	40
Imagery	32	23
Wholist-Analytic Dimension		
Wholist	19	28
Intermediate	58	60
Analytic	23	12

Table 3.22
Table showing an overview of the correlations between the style means, ratios (verbal-imagery and wholistic-analytic) and labels for session 1 (S1) vs session 2 (S2) and for the CSA-A vs CSA-B, on each section and session of the tests.

	Medians (p)	**Dimension VI and WA**	**Ratios (p)**	**Labels (p)**
		CSA-A vs CSA-B (N =50)		
Verbal, CSA-A vs CSA-B, S1	.581 (.000)			
Verbal, CSA-A vs CSA-B, S2	.766 (.000)			
Imagery, CSA-A vs CSA-B, S1	.623 (.000)	VI, CSA-A vs CSA-B, S1	.175 (.223)	.139 (.227)
Imagery, CSA-A vs CSA-B, S2	.779 (.000)	VI, CSA-A vs CSA-B, S2	.358 (.011)	.256 (.046)
Wholistic CSA-A vs CSA-B, S1	.546 (.000)			
Wholistic, CSA-A vs CSA-B, S2	.866 (.000)			
Analytic, CSA-A vs CSA-B, S1	.710 (.000)	WA, CSA-A vs CSA-B, S1	.074 (.609)	.146 (.304)
Analytic, CSA-A vs CSA-B, S2	.873 (.000)	WA, CSA-A vs CSA-B, S2	.301 (.034)	.301 (.034)
		Session 1 vs Session 2 (N = 50)		
Verbal, CSA-A, S1 vs S2	.611 (.000)			
Verbal, CSA-B, S1 vs S2	.712 (.000)			
Imagery, CSA-A, S1 vs S2	.705 (.000)	VI CSA-A, S1 vs S2	.201 (.161)	.100 (.437)
Imagery, CSA-B, S1 vs S2	.624 (.000)	VI CSA-B, S1 vs S2	.202 (.159)	.145 (.254)
Wholistic, CSA-A, S1 vs S2	.731 (.000)			
Wholistic, CSA-B, S1 vs S2	.735 (.000)			
Analytic, CSA-A, S1 vs S2	.817 (.000)	WA, CSA-A, S1 vs S2	.297 (.036)	.341 (.017)
Analytic, CSA-B, S1 vs S2	.861 (.000)	WA, CSA-B, S1 vs S2	.310 (.028)	.225 (.110)

Note. Medians = ccrrelations between the medians; Dimensions = correlations between the dimensions; VI = verbal-imagery dimension; WA = wholistic-analytic dimension; Ratios = correlations between the ratios; Labels = correlations between the labels.

3.8.4 Internal consistency of the CSA-A and the CSA-B

To examine whether the CSA-A and the CSA-B were internally consistent, responses on even and odd items on each section of the test were split creating two halves (odd, even) and then re-analysed . The median reaction times on each half of the split data were not significantly different for all test versions, test sections and test sessions (see Table 3.23).

Tables 3.24-3.26 show the correlations between each half of the split data for each test version and session at each of the three steps of style calculation. At step 1 the reliabilities of the raw reaction times were high (see Table 3.24). Of particular interest are the correlations between odd and even items on the same test version (underlined in Table 3.24) which appear to be especially high, ranging from r = .83 to r = .96. At step 2 the correlations between the verbal-imagery ratios and the wholistic-analytic ratios dropped. The correlations between the ratios calculated on the odd and even halves of the data were especially low for the verbal-imagery ratios (ranging from r = .002 to r = .31) but on the wholistic-analytic dimension the ratio was as high as .764.

Overall, the analysis of the split-half data reveals a familiar pattern. Reliabilities of the raw reaction times were high, but with the calculation of the ratio the correlations fell (see Tables 3.27-3.28 for an overview of the split-half results). The wholistic-analytic dimension continued to be more stable than the verbal-imagery dimension, with stability as high as r = .76.

3.8.5 Stability and internal consistency of the combined CSA-A and CSA-B data

To address Riding's (1998a) concern that there may be insufficient items to examine the CSA's stability and internal consistency and still get a reliable result, each subject's data from the CSA-A was combined with their data from the CSA-B to form a double-sized, or combined CSA (C-CSA). Therefore, the C-CSA had a larger number of items on which to base the cognitive style calculations for each subject. The combined data was firstly re-analysed to examine stability between test sessions and secondly, it was split to examine internal consistency within each test session.

Table 3.23
Mean of the median reaction times for each section of the test (verbal, imagery, wholistic, analytic), each session (S1, S2) and for each split-half of the test (odd items, even items). The difference between the means of odd and even items within the same test is also given.

Test	Section	Mean	Standard Deviation	Difference (p) df=98
CSA-A, S1, odd	Verbal	2619.75	838.3	
CSA-A, S1, even	Verbal	2624.91	816.1	.975
CSA-A, S2, odd	Verbal	2098.37	621.1	
CSA-A, S2, even	Verbal	2122.73	567.8	.838
CSA-B, S1, odd	Verbal	2670.71	805.6	
CSA-B, S1, even	Verbal	2766.44	925.9	.583
CSA-B, S2, odd	Verbal	2106.29	594.2	
CSA-B, S2, even	Verbal	2144.86	598.8	.747
CSA-A, S1, odd	Imagery	2627.93	654.0	.620
CSA-A, S1, even	Imagery	2561.27	684.6	
CSA-A, S2, odd	Imagery	2078.01	545.0	
CSA-A, S2, even	Imagery	2027.60	567.9	.652
CSA-B, S1, odd	Imagery	2606.01	802.7	
CSA-B, S1, even	Imagery	2785.63	949.3	.310
CSA-B, S2, odd	Imagery	2053.16	523.7	
CSA-B, S2, even	Imagery	2129.83	579.6	.489
CSA-A, S1, odd	Wholistic	2012.84	925.7	
CSA-A, S1, even	Wholistic	2144.48	1087.6	.516
CSA-A, S2, odd	Wholistic	1603.10	733.7	
CSA-A, S2, even	Wholistic	1636.48	715.3	.818
CSA-B, S1, odd	Wholistic	2220.57	989.9	
CSA-B, S1, even	Wholistic	2059.05	913.5	.399
CSA-B, S2, odd	Wholistic	1720.13	638.1	
CSA-B, S2, even	Wholistic	1564.24	584.5	.206
CSA-A, S1, odd	Analytic	1660.28	579.9	
CSA-A, S1, even	Analytic	1686.48	565.7	.821
CSA-A, S2, odd	Analytic	1380.13	493.7	
CSA-A, S2, even	Analytic	1392.51	475.6	.899
CSA-B, S1, odd	Analytic	1785.27	666.9	
CSA-B, S1, even	Analytic	1569.63	582.4	.088
CSA-B, S2, odd	Analytic	1467.42	490.8	
CSA-B, S2, even	Analytic	1349.12	422.2	.199

Table 3.24
Pearson's correlations of the median reaction times for the CSA-A and the CSA-B for each section of the test (verbal, imagery, wholistic, analytic) and for each session (S1, S2) which has been split into two halves (odd items, even items). For all correlations N = 50 and p < .03. Items in bold show the correlations within each test section. Items underlined are the correlations within the same test.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Verbal	CSA-A, S1, odd															
2 Verbal	CSA-A, S2, odd	**.515**														
3 Verbal	CSA-B, S1, odd	**.544**	**.687**													
4 Verbal	CSA-B, S2, odd	**.718**	**.697**	**.736**												
5 Verbal	CSA-A, S1, even	**.869**	**.582**	**.546**	**.742**											
6 Verbal	CSA-A, S2, even	**.593**	**.873**	**.693**	**.696**	**.636**										
7 Verbal	CSA-B, S1, even	**.469**	**.734**	**.845**	**.656**	**.536**	**.744**									
8 Verbal	CSA-B, S2, even	**.645**	**.753**	**.662**	**.896**	**.697**	**.700**	**.708**								
9 Imagery	CSA-A, S1, odd	.768	.523	.569	.678	.820	.604	.637	**.649**							
10 Imagery	CSA-A, S2, odd	.580	.880	.758	.784	.645	.901	.806	**.793**	**.607**						
11 Imagery	CSA-B, S1, odd	.446	.717	.814	.587	.466	.759	.861	**.595**	**.590**	**.809**					
12 Imagery	CSA-B, S2, odd	.692	.690	.711	.885	.748	.724	.635	**.839**	**.736**	**.812**	**.617**				
13 Imagery	CSA-A, S1, even	.748	.586	.509	.722	.780	.683	.627	**.735**	**.839**	**.659**	**.562**	**.730**			
14 Imagery	CSA-A, S2, even	.515	.829	.662	.651	.580	.797	.746	**.748**	**.643**	**.848**	**.722**	**.701**	**.682**		
15 Imagery	CSA-B, S1, even	.417	.723	.830	.601	.476	.737	.918	**.630**	**.564**	**.781**	**.876**	**.580**	**.569**	**.730**	
16 Imagery	CSA-B, S2, even	.650	.621	.634	.844	.690	.599	.633	**.873**	**.708**	**.720**	**.551**	**.825**	**.775**	**.674**	**.575**
17 Wholistic	CSA-A, S1, odd	.664	.506	.494	.616	.629	.585	.443	.567	.634	.521	.477	.548	.733	.528	.445
18 Wholistic	CSA-A, S2, odd	.517	.644	.666	.601	.450	.662	.711	.583	.578	.670	.684	.529	.554	.608	.693
19 Wholistic	CSA-B, S1, odd	.310	.514	.740	.468	.325	.572	.712	.439	.430	.529	.757	.456	.400	.443	.688
20 Wholistic	CSA-B, S2, odd	.620	.570	.730	.734	.521	.585	.690	.720	.600	.650	.648	.640	.594	.587	.620
21 Wholistic	CSA-A, S1, even	.742	.517	.504	.663	.680	.608	.441	.628	.671	.555	.515	.640	.759	.563	.440
22 Wholistic	CSA-A, S2, even	.510	.654	.685	.635	.481	.633	.730	.667	.597	.667	.724	.570	.562	.681	.723
23 Wholistic	CSA-B, S1, even	.379	.610	.757	.558	.371	.637	.756	.509	.458	.620	.758	.499	.431	.512	.741
24 Wholistic	CSA-B, S2, even	.541	.665	.754	.759	.473	.620	.755	.752	.527	.703	.680	.649	.592	.605	.692
25 Analytic	CSA-A, S1, odd	.573	.495	.507	.609	.575	.547	.469	.512	.622	.510	.489	.513	.673	.482	.461
26 Analytic	CSA-A, S2, odd	.593	.658	.698	.707	.511	648	.646	.696	.473	.639	.658	.645	.823	.642	.651
27 Analytic	CSA-B, S1, odd	.446	.572	.711	.600	.420	.633	.752	.547	.494	.590	.706	.521	.516	.535	.720
28 Analytic	CSA-B, S2, odd	.519	.632	.638	.650	.414	.467	.585	.613	.457	.638	.622	.549	.535	.565	.572
29 Analytic	CSA-A, S1, even	.640	.533	.557	.662	.593	.559	529	580	.646	.561	.560	.612	.669	.535	.473
30 Analytic	CSA-A, S2, even	.609	.731	.682	.716	.565	.694	.646	.705	.579	725	.663	627	.557	.740	.645
31 Analytic	CSA-B, S1, even	.414	.636	.770	.644	.397	.636	.794	.627	.478	.641	.704	.572	.484	.590	.745
32 Analytic	CSA-B, S2, even	.523	.656	.677	.752	.435	.634	471	.721	.496	.670	.632	.621	561	.583	.615

Table 3.24 continued

Table 3.24 continued

	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
17 Wholistic CSA A, S1, odd	**.584**															
18 Wholistic CSA A, S2, odd	**.521**	**.719**														
18 Wholistic CSA B, S1, odd	**.347**	**.510**	**.695**													
19 Wholistic CSA B, S2, odd	**.682**	**.688**	**.789**	**.652**												
20 Wholistic CSA A, S1, even	**.603**	**.956**	**.687**	**.492**	**.699**											
21 Wholistic CSA A, S2, even	**.579**	**.694**	**.914**	**.691**	**.867**	**.701**										
22 Wholistic CSA-B, S1, even	**.407**	**.581**	**.817**	**.926**	**.719**	**.556**	**.793**									
23 Wholistic CSA B, S2, even	**.670**	**.671**	**.897**	**.700**	**.905**	**.661**	**.869**	**.789**								
24 Analytic CSA A, S1, odd	.517	.870	.754	.610	.689	.818	.709	.666	**.704**							
25 Analytic CSA A, S2, odd	.622	.649	.793	.687	.843	.672	.878	.739	**.833**	**.733**						
26 Analytic CSA B, S1, odd	.427	.604	.838	.741	.758	.578	.826	.927	**.788**	**.736**	**.814**					
27 Analytic CSA B, S2, odd	.588	.736	.814	.652	.821	.706	.789	.745	**.812**	**.785**	**.809**	**.810**				
28 Analytic CSA-A, S2, even	.585	.745	.780	.661	.785	.752	.772	.708	**.769**	**.832**	**.830**	**.762**	**.775**			
29 Analytic CSA-A, S1, even	.674	.686	.732	.572	.838	.704	.886	.675	**.820**	**.708**	**.900**	**.715**	**.837**	**.784**		
30 Analytic CSA-B, S2, even	.527	.547	.800	.803	.787	.523	.807	.876	**.819**	**.661**	**.803**	**.928**	**.824**	**.697**	**.752**	
31 Analytic CSA-B, S1, even	.667	.527	.649	.819	.627	.869	.631	.813	**.737**	**.895**	**.751**	**.847**	**.928**	**.795**	**.846**	**.872**

Table 3.25

Pearson's correlation coefficients for the verbal-imagery and wholistic-analytic dimensions of the CSA-A and the CSA-B for each session (S1, S2) which has been split into two halves (odd, even). All p values are given in brackets. Items in bold show the correlations within each test section. Items underlined are the correlations within the same test.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Verbal-imagery CSA A, S1, odd															
2 Verbal-imagery CSA A, S2, odd	.157 (.275)														
3 Verbal-imagery CSA -B, S1, odd	**.243 (.089)**	**-.033 (.818)**													
4 Verbal-imagery CSA B, S2, odd	**.173 (.229)**	**.149 (.303)**	**.179 (.212)**												
5 Verbal-imagery CSA A, S1, even	**.307 (.030)**	**.023 (.874)**	**.216 (.131)**	**.016 (.910)**											
6 Verbal-imagery CSA A, S2, even	**.356 (.011)**	**.002 (.990)**	**-.009 (.952)**	**.107 (.457)**	**.193 (.178)**										
7.Verbal-imagery CSA B, S1, even	**.019 (.896)**	**.008 (.954)**	**.120 (.408)**	**.109 (.453)**	**.037 (.799)**	**-.056 (.698)**									
8 Verbal-imagery CSA B, S2, even	**.055 (.704)**	**.335 (.017)**	**-.020 (.889)**	**.110 (.445)**	**.246 (.085)**	**.033 (.818)**	**.170 (.238)**								
9 Wholistic-Analytic CSA A, S1, odd	.304 (.032)	-.071 (.625)	.037 (.798)	-.038 (.791)	-.080 (.580)	.028 (.848)	-.045 (.755)	-.135 (.349)							
10 Wholistic-Analytic CSA A, S1, odd	-.161 (.263)	-.142 (.326)	-.066 (.651)	.015 (.919)	-.188 (.192)	-.018 (.903)	.029 (.844)	.007 (.959)	**.303 (.032)**	.					
11 Wholistic-Analytic CSA B, S1, odd	-.235 (.100)	-.039 (.786)	-.122 (.400)	-.119 (.410)	-.107 (.459)	.079 (.587)	-.062 (.670)	-.062 (.668)	**.060 (.681)**	**.101 (.484)**	.				
12 Wholistic-Analytic CSA B, S2, odd	-.052 (.717)	-.215 (.134)	.193 (.178)	.059 (.686)	.055 (.703)	-.175 (.224)	.284 (.046)	-.017 (.908)	**.220 (.125)**	**.091 (.528)**	**.165 (.251)**	.			
13 Wholistic-Analytic CSA A, S1, even	.292 (.040)	-.007 (.961)	.019 (.895)	.059 (.683)	-.114 (.429)	.072 (.617)	-.108 (.455)	.077 (.597)	**.764 (.000)**	**.215 (.135)**	**.017 (.907)**	**.093 (.521)**	.		
14 Wholistic-Analytic CSA A, S2, even	-.279 (.049)	-.055 (.705)	-.150 (.299)	-.057 (.694)	-.257 (.071)	-.191 (.184)	-.010 (.946)	.110 (.447)	**.240 (.094)**	**.562 (.000)**	**.142 (.325)**	**.442 (.001)**	**.229 (.110)**	.	
15 Wholistic-Analytic CSA B, S1, even	-.030 (.836)	-.075 (.603)	-.169 (.240)	.021 (.887)	-.027 (.852)	.174 (.227)	-.186 (.196)	.009 (.950)	**.189 (.189)**	**.288 (.043)**	**.583 (.000)**	**.143 (.323)**	**.211 (.142)**	**.356 (.011)**	.
16 Wholistic-Analytic CSA B, S2, even	.024 (.870)	-.163 (.258)	.133 (.358)	.010 (.946)	.052 (.718)	-.174 (.227)	.049 (.734)	.061 (.673)	**.421 (.002)**	**.401 (.004)**	**.415 (.003)**	**.549 (.000)**	**.325 (.021)**	**.454 (.001)**	**.504 (.000)**

Table 3.26

Kendall's coefficients for the verbal-imagery and wholist-analytic labels of the CSA-A and the CSA-B for each for each session (S1, S2) which has been split into two halves (odd, even). All p values are given in brackets and for all correlations N = 50. Items in bold show the correlations within each test section. Items underlined are the correlations within the same test.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 Verbal-imagery, CSA-A, S1, odd															
2 Verbal-imagery CSA-A, S2, odd	**.208 (.113)**	.													
3 Verbal-imagery CSA-B, S1, odd	**.066 (.616)**	**-.028 (.831)**													
4 Verbal-imagery CSA-B, S2, odd	**.098 (.451)**	**.123 (.340)**	**.252 (.050)**												
5 Verbal-imagery CSA-A, S1, even	**.274** (.036)	**.138** (.289)	**.337** (.009)	**.179** (.162)											
6 Verbal-imagery CSA-A, S2, even	**.248** (.056)	**.094** (.468)	**-.038** (.767)	**.161** (.206)	**.143** (.267)										
7 Verbal-imagery CSA-B, S1, even	**-.039** (.765)	**.051** (.692)	**.209** (.104)	**.061** (.663)	**.095** (.461)	**.064** (.616)									
8 Verbal-imagery CSA-B, S2, even	**.053** (.682)	**.334** (.010)	**.180** (.164)	**.106** (.405)	**.098** (.447)	**.103** (.422)	**.086** (.500)								
9 Wholistic-Analytic CSA-A, S1, odd	.304 (.021)	.129 (.325)	.037 (.776)	.090 (.488)	.142 (.276)	.171 (.187)	.016 (.902)	.133 (.303)							
10 Wholistic-Analytic CSA-A, S2, odd	-.062 (.641)	.079 (.551)	.116 (.379)	.135 (.298)	-.151 (.250)	.099 (.447)	.153 (.239)	.039 (.764)	**.122 (.354)**						
11 Wholistic-Analytic CSA-B, S1, odd	-.101 (.442)	.090 (.491)	-.179 (.171)	-.137 (.288)	-.093 (.474)	.114 (.381)	-.106 (.411)	-.078 (.550)	**.074 (.575)**	**.014 (.915)**					
12 Wholistic-Analytic CSA-B, S2, odd	-.012 (.928)	-.140 (.279)	.137 (.291)	.095 (.457)	.215 (.095)	-.088 (.495)	.168 (.190)	-.016 (.899)	**.334 (.010)**	**.102 (.437)**	**.000 (1.00)**				
13 Wholistic-Analytic CSA-A, S1, even	.171 (.188)	.148 (.251)	.047 (.716)	.190 (.137)	.29 (.823)	.208 (.104)	.051 (.687)	.078 (.544)	**.537 (.000)**	**.238 (.068)**	**-.012 (.926)**	**.067 (.600)**			
14 Wholistic-Analytic CSA-A, S2, even	-.233 (.074)	.142 (.273)	-.085 (.515)	-.034 (.790)	-.088 (.495)	-.150 (.244)	-.054 (.677)	.077 (.550)	**-265 (.042)**	**.482 (.000)**	**.086 (.510)**	**.403 (.002)**	**.25 (.049)**		
15 Wholistic-Analytic CSA-B, S1, even t	.053 (.685)	.039 (.762)	-.179 (.167)	.035 (.786)	.004 (.976)	.162 (.209)	-.184 (.151)	-.008 (.953)	**.307 (.018)**	**.040 (.761)**	**.497 (.000)**	**.129 (.318)**	**.206 (.109)**	**.22 (.090)**	
16 Wholistic-Analytic CSA-B, S2, even	-.017 (.97)	-.040 (.763)	.152 (.248)	.130 (.315)	.153 (.242)	-.045 (.730)	.061 (.639)	.157 (.229)	**.329 (.013)**	**.239 (.072)**	**.127 (.337)**	**.440 (.001)**	**.303 (.020)**	**.370 (.005)**	**(.000)**

Table 3.27
Table of split-half correlations (odd, even) between the means, ratios and labels for each version of the test (CSA-A, CSA-B), section of the test (verbal, imagery, wholistic, analytic) and each session (S1, S2).

	Correlation of Means (p)	Dimension (VI) verbal-imagery (WA) wholistic-analytic	Pearson's correlations for the Ratios	Significance of Ratios	Kendall's Coefficients for the Labels	Significance of Labels
Verbal CSA-A, S1, odd vs even	.869 (.000)					
Verbal CSA-A, S2, odd vs even	.873 (.000)					
Verbal CSA-B, S1, odd vs even	.845 (.000)					
Verbal CSA-B, S2, odd vs even	.896 (.000)					
Imagery CSA-A, S1, odd vs even	.839 (.000)	VI CSA-A. S1, odds vs evens	.307	.030	.274	.036
Imagery CSA-A, S2, odd vs even	.848 (.000)	VI CSA-A. S2, odds vs evens	.002	.990	.094	.468
Imagery CSA-B, S1, odd vs even	.876 (.000)	VI CSA-B. S1, odds vs evens	.120	.408	.209	.104
Imagery CSA-B, S2, odd vs even	.825 (.000)	VI CSA-B. S2, odds vs evens	.110	.445	.106	.164
Wholistic CSA-A, S1, odd vs even	.956 (.000)					
Wholistic CSA-A, S2, odd vs even	.914 (.000)					
Wholistic CSA-B, S1, odd vs even	.926 (.000)					
Wholistic CSA-B, S2, odd vs even	.905 (.000)					
Analytic CSA-A, S1, odd vs even	.832 (.000)	WA, CSA-A, S1, odds vs evens	.764	.000	.537	.000
Analytic CSA-A, S1, odd vs even	.900 (.000)	WA, CSA-A, S2, odds vs evens	.562	.000	.482	.000
Analytic CSA-B, S1, odd vs even	.928 (.000)	WA, CSA-B, S1, odds vs evens	.583	.000	.497	.000
Analytic CSA-B, S2, odd vs even	.928 (.000)	WA, CSA-B, S2, odds vs evens	.549	.000	.440	.001

Table 3.28
Table of correlations for C-CSA session 1 (S1) vs session 2 (S2) and C-CSA odd vs even items at each section and session (N = 50).

	Medians (p)	Dimension VI and WA	Ratio (p)	Labels (p)
		C-CSA, S1 vs C-CSA, S2		
Verbal, C-CSA, S1 vs S2	.823 (.000)			
Imagery, C-CSA, S1 vs S2	.846 (.000)	VI C-CSA S1 vs S2	.266 (.061)	.205 (.111)
Wholistic, C-CSA, S1 vs S2	.877 (.000)			
Analytic, C-CSA, S1 vs S2	.925 (.000)	WA C-CSA S1 vs S2	.532 (.000)	.381 (.005)
		C-CSA, Odds vs C-CSA, Evens		
Verbal, C-CSA, S1, odd vs even	.869 (.000)			
Verbal, C-CSA, S2, odd vs even	.959 (.000)			
Imagery, C-CSA, S1, odd vs even	.916 (.000)	VI C-CSA S1, odd vs even	.292 (.039)	.245 (.056)
Imagery, C-CSA, S2, odd vs even	.924 (.000)	VI C-CSA, S2, odd vs even	.422 (.022)	.215 (.091)
Wholistic, C-CSA, S1, odd vs even	.954 (.000)			
Wholistic, C-CSA, S2, odd vs even	.971 (.000)			
Analytic, C-CSA, S1, odd vs even	.933 (.000)	WA CSA-A, S1, odd vs even	.685 (.000)	.512 (.000)
Analytic, C-CSA, S2, odd vs even	.956 (.000)	WA CSA-A, S2, odd vs even	.693 (.000)	.518 (.000)

Note. Means = Correlations between the medians; Dimensions = Correlations between the dimensions; VI = Verbal Imagery dimension; WA = Wholist Analytic dimension; Ratios = Correlations between the ratios; Labels = Correlations between the labels

Table 3.28 shows that the stability and the internal consistency of the combined data are higher at each step of style calculation than the stability and internal consistency of the CSA-A or the CSA-B alone (compare Table 3.22 with 3.27 and 3.28). Although the combined data also show the familiar pattern of falling correlations with each subsequent style calculation, the correlations only show a substantial drop on the verbal-imagery dimension. Indeed, the most important finding of this study was that the split-half reliability of the wholistic-analytic ratio from the C-CSA approached a satisfactory level of $\underline{r} = .7$ and this was repeated at a second sitting.

3.9 Discussion

The results presented above suggest that the CSA-A and the CSA-B were suitable parallel tests as both tests generated similar error rates and average reaction times. Furthermore, subjects' average reaction times were highly correlated between the two test versions and over time. Despite the fact the CSA-A and the CSA-B can be considered parallel tests, the results suggest that the CSA-A and the CSA-B in their current form are not stable or internally consistent measures of cognitive style preference. This is because the reliability of the crucial style ratios, which determine cognitive style preference, were poor. This finding has recently been confirmed by Redmond, Mullaly & Parkinson (2002) who administered the original CSA twice over a 12-day period. They also found the reliability of the wholistic analytic dimension ratio to be moderate (r = .556) at retest, but the verbal-imagery dimension ratio was low and negative at retest (r = -.166). Redmond et al., also concluded that the reliability of the CSA was below acceptable levels for a psychometric test.

The C-CSA (which is the combined CSA-A and CSA-B test) is however not a redundant test because when the CSA-A is combined with the CSA-B, to make a longer test with more items, the split-half reliability of cognitive style preferences on the wholistic-analytic dimension approaches a reliability of $\underline{r} = .7$. In other words, the extended CSA wholistic-analytic dimension of cognitive style preference (Extended CSA-WA) meets the reliability criteria for a psychometric test, but the extended verbal-imagery dimension of style preference does not.

More specifically, analyses of all the reliability results on the CSA-A and CSA-B alone revealed a persistent pattern. The initial session 1 versus session 2 and CSA-A versus CSA-B median reaction times were all highly correlated within each task section (verbal, imagery, wholistic, analytic) suggesting stability and internal consistency. The high correlations also reflect the use of a reaction time measure where most participants responded within a narrow response range: with a floor effect at around 1000 milliseconds and most responses falling between 1000-3000 milliseconds. However, as the cognitive style preference ratios (which are the key variables of interest) were calculated for each dimension and the style labels allocated, the correlations fell below what is acceptable for a psychometric test.

The most encouraging result of the present study is that wholistic-analytic style ratios based on the combined (CSA-A, CSA-B) data approached a split-half reliability of $r = .7$. Since the ratios are approximately normally distributed, there is no good statistical reason to allocate people further into style categories. Therefore, by using the combined CSA-A and CSA-B, people can reliably be categorised on the wholistic-analytic dimension. The verbal-imagery dimension however, needs to be reviewed.

As noted above, the key variables of interest in this study were the consistency of the individual differences in reaction times and specifically the reliability of the reaction time ratios. For this reason the analysis of variance results, which examined differences in overall mean reaction time, were not considered important as they tell us nothing about the individual differences in style preferences. Nevertheless, some of the anova results and examination of the test errors produced some interesting findings.

As expected, the verbal and imagery items resulted in more errors than the wholistic and analytic items on the CSA-A and the CSA-B. In addition, the items that were particularly difficult were those argued to be of a similar colour e.g., 'Cream and Paper' or a similar category e.g., 'Beans and Chicken.' The difficulty probably arose because very few objects are exactly the same colour or type. In contrast, the wholistic and analytic items clearly only have one correct answer; the shape is either exactly the same or it is not, or the shape is embedded in the larger complex shape or it is not. It is likely that the increased difficulty of the verbal and imagery items is further reflected in the more changeable nature of the verbal-imagery ratios and consequently in the more unstable identification of a person's style category on the verbal-imagery dimension.

A main effect was found for the session in which the experiment was sat, with performance at session 2 being consistently faster than performance at session 1. This probably reflects an underlying practice effect where participants respond faster at retest because the nature of the test becomes more familiar. This practice effect is also assumed to be the underlying cause of the interactions between version and order and version, session and order. With each subsequent test taken (irrespective of order or version) resulting in a faster overall reaction time. Furthermore, it appears that the biggest change in overall reaction time occurred between the first and the second test (i.e., within session 1), suggesting that this is where most of the learning occurred. In contrast, there was little change in overall reaction time between the second, third and fourth tests taken, irrespective of the test version or test order.

3.9.1 Limitations of the CSA

On reflection, there appear to be two major limitations of the CSA which may be contributing to its low reliability as a measure of cognitive style. The first is that the verbal-imagery dimension is less stable than the wholistic-analytic dimension and the second is the problem with the manner in which the style category is calculated and assigned.

Verbal-imagery dimension: why was it unreliable?

The results of this study clearly show that the verbal-imagery dimension of the CSA-A and CSA-B is less stable than the wholistic-analytic dimension. The reasons for its instability are unclear. It is possible that responding on the verbal-imagery dimension is more varied because the verbal-imagery dimension questions ("Are X and Y the same Colour?" or "Are X and Y the same type?") are more subjective than the wholistic-analytic dimension questions. It is also possible that the individual differences in verbal-imagery processing are not as prevalent as the individual differences in wholistic-analytic processing. Indeed, it is interesting to note that, compared to the wholistic-analytic dimensions, there has been little empirical investigation into the possibility of their being a competing verbal-imagery dimension. Indeed, research into how people cognitively process words has largely occurred separately from research on how people process images. Although individual differences in verbal and visual information processing have been found (Richardson, 1999), there has been little empirical investigation into the possibility of there being a competing verbal-imagery dimension and a preference for using one particular end of it. In this sense, there is evidence for individual differences in ability to use verbal and visual information, but whether there is a preference or cognitive style underlying this ability remains unclear. Therefore, although Riding & Cheema (1991) give examples of tests that have been designed to measure the verbal-imagery dimension (e.g., Riding & Taylor's Verbalizer-Imagery, 1976; Richardson's Verbal-Imager, 1977), the evidence for this dimension is not extensive, and it is substantially less than the evidence for the wholistic-analytic dimension. In contrast, the wholistic-analytic dimension is argued to be the dimension from which most style research grew (Desmedt & Vackle, 2002) and as a result it has been investigated under various guises since the late 1940s (e.g., Field Dependence-Independence, Witkin & Asch, 1948a, 1948b; Levellers and Sharpeners, Holzman & Klein, 1954; Impulsivity and Reflectivity, Kagan, Rosman, Day, Albert, & Philips, 1964; Divergent-Convergent Thinking, Guilford, 1967; Holist Serialists, Pask & Scott, 1972 etc.). More research is needed into what causes the underlying instability of the verbal-imagery dimension. That is, researchers need to investigate whether it is the style dimension or the nature of the test which causes the instability or seriously consider whether there is a verbal-imagery preference at all.

Why did the correlations fall: the use of the ratio

The results also show a consistent pattern of falling correlations with each subsequent step of the cognitive style calculation. This may be due in part to the use of a ratio to determine an individual's style preference. The problem is that even if the measure of performance on each section of the CSA (verbal, imagery, wholistic and analytic) was stable, the process of defining an individual's style by dividing an individual's verbal score by their imagery score and their wholistic score by their analytic score, decreases stability. This is because, any measure that is computed as a difference between other measures is less reliable than a single measure (Lohman, 1999). In this way, it is possible that the lower reliability of the style ratios, which are then used to determine the style categories, may to some extent underlie the subsequent lack of reliability of style category allocation.

Potential limitations of the study

The test-retest interval in this study was small ($\underline{M}$ = 8.5 days). Riding (1998a) suggested that a test-retest interval of approximately a year is needed because subjects may remember the questions on a second sitting and therefore may respond faster at session 2. Indeed the results indicated that there was a practice effect with session 2 performance being faster than session 1. However, to determine a cognitive style preference, the CSA constructs a verbal-imagery ratio and a wholistic-analytic ratio and provided that the participants at session 2 respond faster on all sections of the task (verbal, imagery, wholistic and analytic), then the ratio of verbal to imagery and wholistic to analytic responses will not change between session 1 and session 2. Furthermore, if style has "temporal stability" (Riding & Rayner, 1998), then a within subjects comparison should have no time-based effects. Nevertheless, to avoid the potential criticism that practise may have affected our test-retest results, the current study also constructed a parallel test. Subject performance on the original and parallel test was then compared to check for stability. The results showed that the correlations between the style preference ratios and style labels on the original and parallel forms were still below the acceptable level for a psychometric test. Note that the split-half reliability results are not affected by the test-retest interval problem.

Riding (1998a) also suggests that doubling the length of the CSA may make it too long for a subject to do without fatigue. The current experiment allowed 5 minutes between the sitting of CSA-A and the CSA-B and hence it could be argued that the testing session was too long and the break between test versions too short. However, there is no evidence in the literature to suggest that the current length of the CSA is the only length that will get an effect. Nevertheless, to counteract any potential criticism, this study counterbalanced the presentation of the CSA-A and the CSA-B. In other words, if the CSA-A were sat first at session 1, it was sat second at session 2 and vice versa. This allowed the experimenter to compare performance on the original and parallel tests that were sat first either at each session 1 or at session 2 and therefore no learning and no fatigue should have occurred. The results showed that even when performance was compared between the tests sat first at each session, the stability was below acceptable levels for a psychometric test. In addition, the result clearly indicate that when the subjects' performance on the CSA-A and the CSA-B was combined (creating the C-CSA), the correlations between session 1 and session 2 performance increased. Indeed by combining the CSA-A and CSA-B, the wholistic-analytic dimension became acceptably stable. Thus, contrary to the suggestion of fatigue, the longer test improves stability.

A potential criticism of the parallel test was that some objects used on the verbal imagery section of the parallel test were also used on the original test. This was primarily because the pilot studies had shown that it was very difficult to find objects that were associated with only one colour and hence could be used for the imagery question "Are X and Y the same colour?" However, the item objects that were reused always appeared in novel pairs and hence the test items (word pairs) on the parallel test required a different conceptualisation from the original CSA. It is therefore unlikely that the repeated words significantly affected the results.

Another possible criticism of the study is that the majority of the participants were undergraduate students at Edinburgh University and therefore it is likely that the sample was of above average ability. However, Riding (1997) has argued that cognitive style, as measured by the CSA is independent of intelligence and therefore the select nature of the participants should not have affected the results. Furthermore, the use of the ratio to look at responding preference rather than actual scores effectively removes any ability factor in the responding (Riding, in press).

In conclusion, this study is the first to thoroughly investigate the effects of the structure of Riding's (1991, 1998) CSA on participant performance, the first to design a successful parallel CSA test and the first to investigate whether the CSA is internally consistent and reliable.

As hypothesised, on both the original CSA (CSA-A) and the parallel test (CSA-B), participants made more errors on the verbal-imagery items than they did on the wholistic-analytic items and they had more difficulty with items that were argued to be the same colour or type as opposed to those items that were different colours or types. In addition, as expected, participants also responded faster at session 2 and made fewer errors on session 2 than they did on session 1.

The most important findings of this study were that the reliability and the internal consistency of the CSA-A and the CSA-B ratios were low and not as expected. These key findings, along with the results of the combined CSA (C-CSA) are summarised in Table 3.29 below. Table 3.29 shows that the CSA-A and the CSA-B showed poor test-retest reliability and were not internally consistent at both session 1 and session 2. However, the most promising finding of this study was that when the CSA-A was combined with the CSA-B to create the C-CSA, the reliability of the wholistic analytic dimension had a promising test-retest reliability of $r = .53$ and good internal consistency of $r = .69$ (at both session 1 and session 2). The reliability of the verbal-imagery dimension on the C-CSA did not improve.

Regardless of what causes the instability of the original and parallel form of the CSA, the findings of this study suggest that those who take the CSA and use its findings to make decisions about for example, education or training, should be made more aware of its

Table 3.29

Table highlighting the main test-retest and internal consistency correlations for the original CSA (CSA-A), the parallel version of the CSA-A (CSA-B) and the Combined CSA (C-CSA)

Test-Retest (Session 1 vs Session 2)		
	Verbal-Imagery	Wholistic-Analytic
Original CSA (CSA-A)	.201	.297
Parallel CSA (CSA-B)	.202	.310
Combined CSA (C-CSA)	.266	.532

Internal Consistency (odds vs evens)			
	Session	Verbal-Imagery	Wholistic-Analytic
Original CSA (CSA-A)	1	.314	.620
	2	.048	.482
Parallel CSA (CSA-B)	1	.213	.529
	2	.132	.523
Combined CSA (C-CSA)	1	.292	.685
	2	.422	.693

instability as a measure. In addition, those studies that have used this measure to look at the relationships with factors such as personality, intelligence and behaviour may need to be reviewed. Researchers also need to be made aware that an extended version of the CSA's wholistic-analytic dimension (Extended CSA-WA) is acceptably stable and internally consistent.

Chapters 4 and 5 will examine whether it is possible to design a new more reliable measure of the wholistic-analytic and verbal-imagery dimension of cognitive style based on the model proposed by Riding & Cheema in 1991.

Chapter 4

Inspection Time and Wholistic-Analytic Cognitive Style

Marco Polo describes a bridge, stone by stone

> "But which is the stone that supports the bridge?" Kublai Khan asks.
> "The bridge is not supported by one stone or another," Marco answers, "but by the line of the arch that they form."
> Kublai Khan remains silent, reflecting. Then he adds, "Why do you speak to me of stones? It is only the arch that matters to me." Polo answers: "Without stones there is no arch."

Italo Calvino (1972, p. 82).

As this quote suggests, people can structure information in different ways. In this example Kublai Khan and Marco Polo each describe the bridge taking both analytic and wholistic approaches, seeing either stones or the whole arch.

The aim of this experiment was to examine whether wholistic-analytic style preferences for the way information is structured could be investigated from an information processing framework and specifically when using an inspection time paradigm.

4.1 Introduction

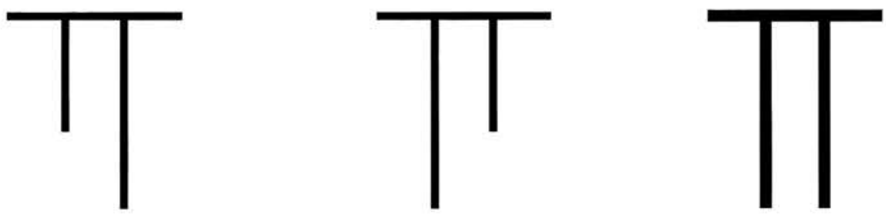
As noted in Chapters 2 and 3, the wholistic-analytic dimension is one of the more established cognitive style dimensions (Desmedt & Vackle, 2002, Riding & Cheema, 1991) and many different ways of measuring it have been proposed. Most have been criticised for lacking evidence of reliability and validity (e.g., Impulsivity-Reflectivity, Category Width, Levellers & Sharpeners, Holist-Serialists) or for being inappropriately measured and failing to meet the criteria of a style (Field-Dependence-Independence, Impulsivity-Reflectivity, Levellers & Sharpeners) (see Table 1.2 and 1.3 for more details). Chapters 1 and 2 suggested that Riding's (1991) CSA was a break-through for style research because, despite lacking evidence of reliability, it did avoid many of the problems that befell other wholistic-analytic tests (see Table 1.3). Chapter 3 however, found that only when Riding's CSA test of the wholistic-analytic dimension was doubled in length to create the Extended CSA-WA did its reliability approach an acceptable level for a psychometric test.

Although the Extended CSA-WA test, compared to other tests of the same dimension, looks promising (with test-retest reliabilities of .53 and internal consistency of .69), one problem underlying all of these tests might be that they are trying to look for style differences in unnecessarily complicated, higher order tasks.

Many of the tests for the wholistic-analytic dimension are derived from the psychometric tradition rather than the information processing tradition and hence they tend to involve higher order processing such as recognition, problem solving and/or reasoning. Also, they are often performed slowly, allowing more time for decision making. However, the definition of cognitive style is a preferred or habitual way of processing information (Allport, 1937). Therefore, a task that taps more closely into lower level processing might be a more successful way of measuring habitual individual differences in cognitive style. In addition to being more successful, this approach might also be more tractable – offering an understanding of style at a theoretically informative level.

4.1.1 An information processing approach: inspection time

Inspection time studies take a reductionistic approach to the investigation of information processing. Unlike psychometric approaches to information processing, inspection time is a psychophysical approach that identifies limitations in fundamental processing speed. More specifically, inspection time measures how long a stimulus needs to be presented in order for it to be perceived correctly (Cooper, 1998). A typical inspection time task involves presenting a participant with a stimulus (e.g., Shape A or Shape B) for a brief interval (a few thousandths of a second), which is followed by a mask (e.g., Shape C), which helps to limit the impact of higher-level cognitive strategies on performance (Nettelbeck, 2001). The participant is then asked a simple question about the stimulus such as 'was the longer line on the left or on the right?'. The experimenter is interested in finding out at what stimulus exposure the subject's response accuracy increases above chance and reaches a given accuracy level. In other words, a visual inspection time task is designed to capture individual differences in the capacity to detect information in a stimulus, or aspect of a stimulus, which is displayed for a very brief period (Nettelbeck, 2001). The exposure duration at which the subject achieves a given level of accuracy differs between individuals, resulting in an individual difference measure which is arguably 'free from all difficulties of discrimination other than temporal limitations' (Deary, 1999, p 117).



Shape A Shape B Shape C

Figure 4.1
Examples of stimuli for a visual inspection time task

One advantage of inspection time tasks is that there is no need for the subject to respond quickly because only the correctness of the responses at each duration is recorded. Hence, inspection time tasks give the experimenter greater control over the temporal parameters, as well as providing a simple task that may relate to the more basic limitations in perceptual processing. That is not to say that inspection time measures the speed of a single mechanism. Indeed, Nettelbeck (2001) has suggested that attentional capacities, selective attention, control of rapid scanning and perhaps visualisation and spatial orientation abilities may also be involved. Nevertheless, according to Nettlebeck, these functions of inspection time tasks are "generally 'low-level' in the sense that any learning involved in their acquisition is implicit and not dependent on conscious intent" (Nettelbeck, p.460).

Since the retina is essentially an outgrowth of the brain, it is possible that people with accurate or rapid neurons will be able to make the simple low level discriminations more quickly than others (Cooper, 1998). It is also possible that highly intelligent people will be able to detect the stimulus after a shorter exposure time than those with lower ability. To date, the majority of research on inspection time has looked at correlations between general intelligence and inspection time ability and most of the correlations have been found to be between -.3 to -.5 (Cooper, 1998). Indeed, the association between inspection time and intelligence is argued by Petrill and Deary (2001) to be "one of the most enduring findings concerning the cognitive processes and possible biological underpinnings associated with human intelligence differences" (p.441).

Although the psychological processes underlying performance on inspection time tasks are still unknown (Deary, 2000), one might expect that, like inspection time and intelligence, individuals with a particular style preference will process stimuli that tap into their style correctly after a shorter time than those with the opposite style preference. For example, if presented with a stimulus, which has both wholistic and analytic properties, such as a circle divided into wedges (like a round of cheese), wholists might notice the circle quicker whereas analytics might notice the wedges quicker.

4.1.2 Assessing cognitive style with inspection time

As suggested above, one way to measure the wholistic-analytic style using inspection time is to find stimuli that are easy to process and have wholistic and analytic properties. Using stimuli with wholistic and analytic properties has the advantage that the stimuli can be kept the same for the wholistic and analytic tasks, allowing for a closer comparison between performance on the two tasks. One type of stimuli that meet these criteria are Navon stimuli (Navon, 1977).

Navon stimuli

Navon stimuli are hierarchically constructed so that larger figures are built from smaller figures. For example, Figure 4.2 shows a large global letter S built out of many local Hs. Navon stimuli are particularly useful for examining wholistic (global) tendencies and analytic (local) tendencies because both features are present within the one stimulus yet one cannot be predicted on the basis of the other. Furthermore, it is argued that the larger figure and the smaller figure are equally recognisable, complex, and codable (Kimchi, 1992).

These properties of Navon stimuli make them an ideal basis for examining whether local and global (or wholistic and analytic) aspects can be identified with equal speed and/or how interference between the local and global levels can affect task performance.

```
 HHHHH
H
 HHHHH
      H
      H
HHHHH
```

Figure 4.2
Example of Navon type stimulus

Previous Research using Navon Stimuli

Global precedence effect

Navon (1977) first used hierarchical stimuli in a Stroop-like interference task. Navon found that when the local and global levels of the stimulus conflicted, e.g., a large S made up of small Hs, the identification of the global S was not affected, but the identification of the local H was reduced. This effect was termed the global precedence effect (Navon, 1977) and it has been repeatedly demonstrated in a large number of studies (e.g., Fuentes & Vivas, 2000; Fink, Marshall, Halligan, Dolan, 1999; Christman & Weiner, 1997; Pagquet, 1994, 1999a, 1999b; Mena, 1992; Kimchi, 1992; Kimchi & Merhav, 1991; Polich & Arguilar, 1990).

Kimchi (1992) notes that the global precedence effect does not necessarily mean that the global shape is more salient, but that global properties are processed before local properties suggesting global superiority (Kimchi, 1992). Hence the global precedence is a theoretical account of the empirically established global advantage (Kimchi, 1992).

Many researchers have tried to find the source of the global precedence effect and research has shown that many factors may be involved (Fink, Marshall, Halligan, Dolan, 1999;

Christman & Weiner, 1997; Paquet, 1994, 1999a, 1999b; Mena, 1992; Kimchi, 1992; Kimchi & Merhav, 1991; Polich & Arguilar, 1990). These include overall visual angle (Blanca Mena, 1992), retinal location (Boles & Karner, 1996), spatial uncertainty (Fuentes & Vivas, 2000), scarcity and number of elements (Kimchi & Merhav, 1991; Christman, & Weiner, 1997), goodness of form (Polich, Arguilar, 1990), type of local and global stimulus (Kimchi & Merhav, 1991), attention (Paquet, 1994; Paquet, 1999a, 1999b) and exposure duration (Paquet & Merikle. 1984,1998; Kimchi, 1998).

More specifically, researchers have found that the global advantage occurs for stimuli that subtend a visual angle of less than 10 degrees, provided that the distance from the fovea is held constant (Kinchla & Wolfe, 1970; Navon & Norman 1983; Kimchi, 1992; Blanca Mena, 1992). This finding suggests that the global precedent effect does not occur for large stimuli.

Paquet (1999) and Kimchi & Merhav (1991) found that spatial uncertainty (not knowing where the stimulus will be presented on a screen) affected the global advantage in that no global advantage was found with unpredictable stimulus presentations, but a global advantage was found for fixed central presentations. This suggests that the global precedent effect occurs with focused attention rather than distributed attention.

Studies investigating the number of local elements and the global advantage have found that when the local items are further apart, but the visual angle is still held constant, there is a local advantage. That is, people perceive the local items first. However, when the local stimuli are close together, a global advantage occurs. This effect is confounded with the contours of the elements, clarity of the global form (sparse local objects make a less defined global form) and the problem that local letters close together start looking like a texture rather than individual items (Kimchi, 1992; Christman & Weiner, 1997).

Similarly, Paquet (1999) thought that use of different shapes might underlie the global advantage. In particular, Paquet suggested that distinct feature differences at the global and local level might interfere with global and local processing by allowing subjects to adopt strategies. For example, the letter 'O' differs substantially from the letter 'H' in part because it does not have a central horizontal line. Hence subjects could adopt the strategy "look for the central line, if found, respond 'H'". Paquet however, found that the global advantage was retained irrespective of whether stimuli with similar figural properties were used.

The type of hierachical global and local stimuli used has also been found to affect the global advantage. To investigate this, Necka (1999) constructed incongruent hierarchical and neutral hierarchical stimuli. The incongruent stimuli were the same as Navon's (1977) original task in that they consisted of a global letter H made up of local Ks, or a global N made up of local Zs (see Figure 4.3). However, for the neutral condition, Necka used a global rectangle made up of local Rs and a global T made up of local *s (see Figure 4.4). Necka found a global advantage only for the incongruent stimuli (i.e., Figure 4.3), but no global advantage was found for the identification of the global and local levels of the neutral stimuli (i.e., Figure 4.4). This suggests that if neutral global or local stimuli are used, the global advantage may not occur.

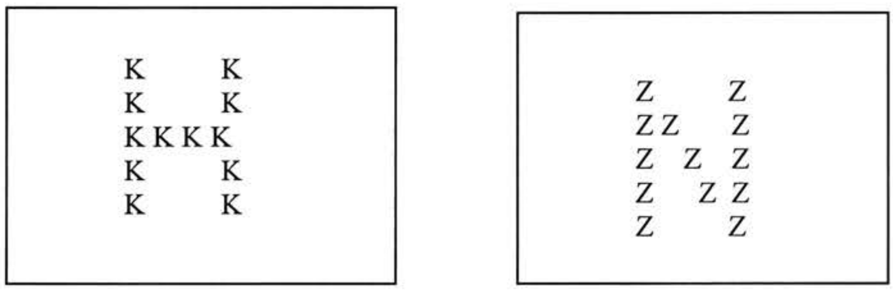


Figure 4.3
Incongruent stimuli used by Necka (1999)

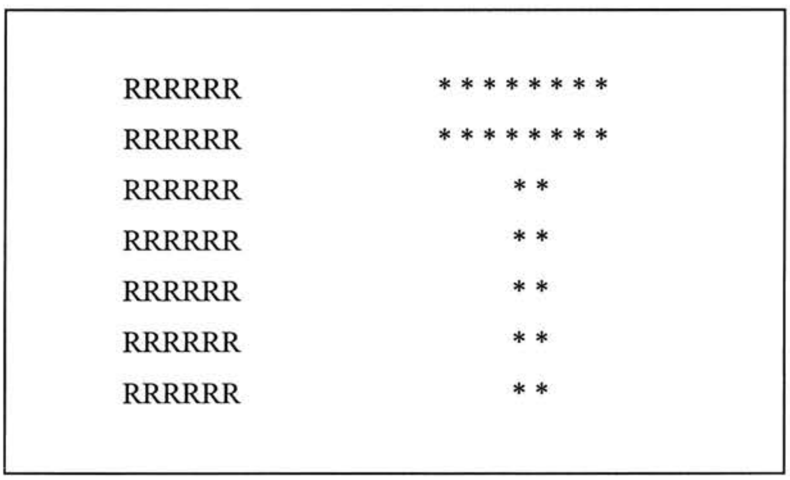


Figure 4.4.
Neutral stimuli used by Necka (1999)

The influence of exposure duration was initially thought to affect the global advantage as well. Paquet and Merikle (1984) have found that the global advantage occurred only at short duration (10ms), with mutual interference occurring at the longer durations (40ms, 100ms). However since then, other researchers have found the global advantage at longer durations as well (Kimchi, 1998, Wandmacher & Arend, 1985, Paquet & Merikle, 1988), suggesting that the global advantage occurs irrespective of the exposure duration.

Together, these studies suggest that a global advantage will result if the traditional Navon (1977) stimuli are used (e.g., stimuli like Figure 4.2 and Figure 4.3), if they subtend less than 10 degrees of visual angle, the elements are relatively close together and presented in a constant place. As this study is interested in looking for individual differences in preferences for global and local processing (or wholistic-analytic processing), ideally a task where the participants are not biased to one form of processing (i.e., a task where the global precedent effect does not occur) should be used. From the results suggested above, it appears that if neutral hierarchical stimuli are used (e.g., Figure 4.4), no global precedence effect should occur, and therefore they will be used in the current study to look for individual differences in wholistic-analytic dimension preferences.

Individual differences and Navon stimuli

To date, no research has been conducted to look specifically at how individuals differ in performance on Navon stimuli; that is, whether some people are more strongly affected by the global advantage than others. Instead, most of the research has concentrated on what stimulus aspects cause the global advantage across all subjects.

This study aims to investigate whether individual differences in performance on neutrally constructed Navon stimuli (where there is argued to be no global advantage) are reliable and whether they could be accounted for by individual differences in cognitive style. For example, a person with a more wholistic cognitive style may perform particularly well when identifying the global aspect of the stimulus but have problems in identifying the local aspect of the stimulus, whereas an analytic person may perform substantially better on identifying the local level of the stimulus compared to the global level of the stimulus.

To investigate this, two categories of neutral hierarchical stimuli (global and local) were designed for this study. The global stimuli consisted of a global letter E made up of 2s or 7s, or a global letter F made up of 2s or 7s (see Figure 4.5). The local stimuli consisted either of Es that formed a global 2 or 7, or of Fs which formed a global 2 or 7 (see Figure 4.6). Hence, every stimulus consisted of one type of letter (E or F) and one type of number (2 or 7). The letters E and F and numbers 2 and 7 were chosen because they were argued by the experimenter to have similar figural properties (i.e., they differed only in the presence or absence of one drawn line). They were also drawn so that the elements were close together and subtended an angle of less than 10 degrees.

In summary, this pilot study will investigate whether i) there are individual differences in performance on an inspection time task that uses neutrally constructed Navon type stimuli; ii) these individual differences are stable at retest; and iii) these individual differences on the inspection time wholistic-analytic task relate to cognitive style as measured by the wholistic-analytic dimension of the CSA.

4.2 Method

4.2.1 Participants

Twenty participants (14 females, 6 males) took part in the pilot study. Subjects age ranged from 18-46 (M = 24.85, SD = 6.88). The majority of participants were students at the University of Edinburgh.

4.2.2 Apparatus

The wholistic-analytic dimension of the CSA (CSA-WA) and the inspection time version of the wholistic-analytic dimension (WA-IT) were presented using an E-PRIME computer programme. Both experiments were presented on a Sony monitor set to display 640 x 480 pixels, 8 bits of colour, with a screen refresh rate of 160 Hz. The stimuli for the CSA-WA were the same as those used in the wholistic and analytic sections of Riding's (1991) original CSA (see Chapter 3 for more details).

The stimuli for the WA-IT were made using Microsoft Paint. There were two categories of stimuli (global and local) with four examples from each category, giving a total of eight possible stimuli, which were presented twice. The global stimuli consisted of a global letter E made up of 2s or 7s, or a global letter F made up of 2s or 7s (see Figure 4.5). The local stimuli

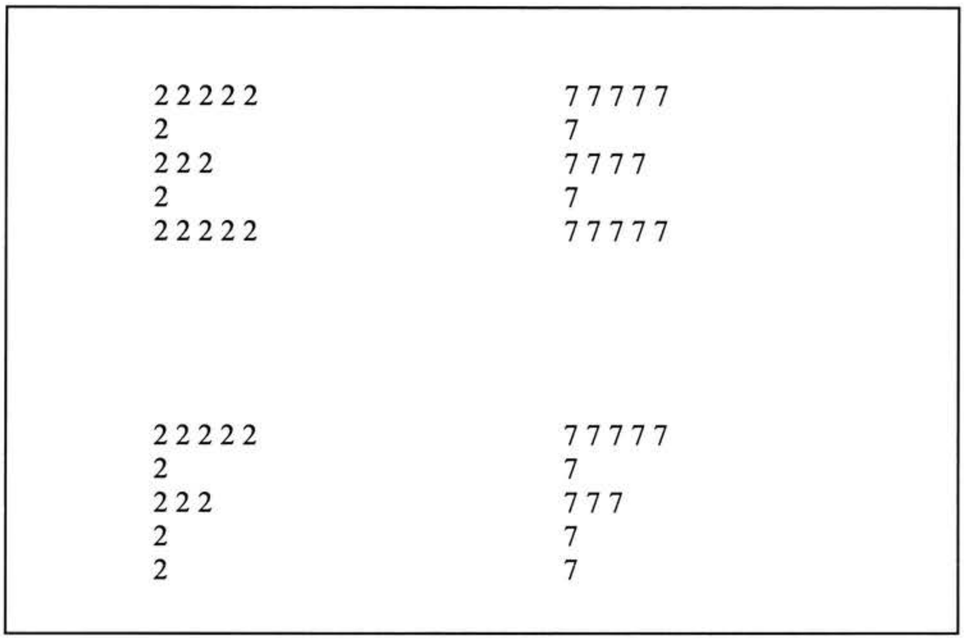


Figure 4.5

Global target stimuli used in the WA-IT task

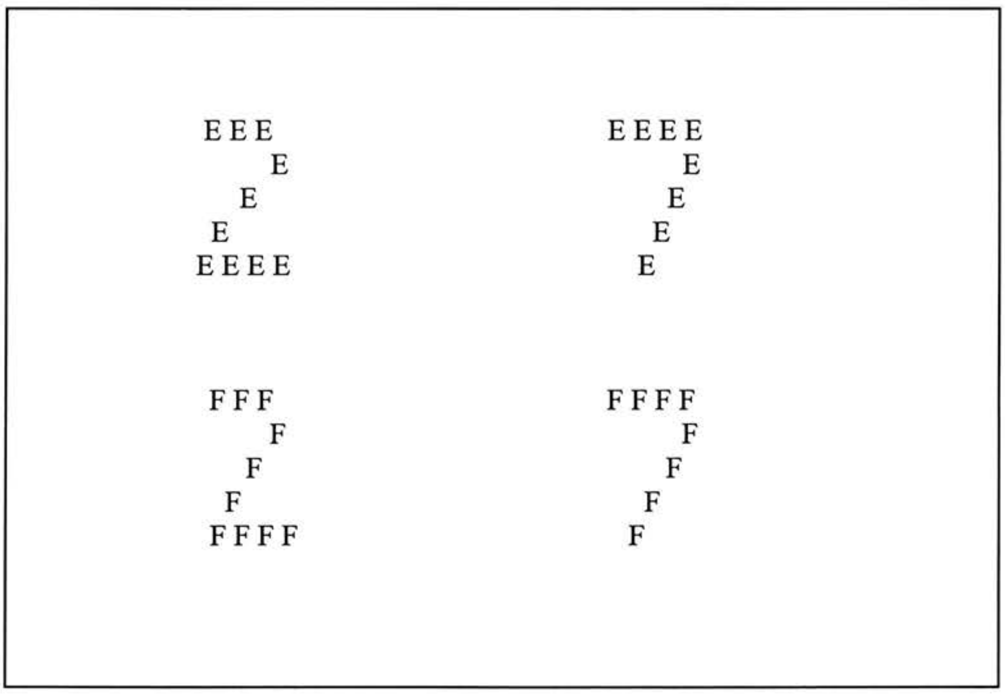


Figure 4.6

Local target stimulus used in WA-IT task consisted either of Es that formed a global 2 or 7, or of Fs which formed a global 2 or 7 (see Figure 4.6). Therefore, every stimulus consisted of one type of letter and one type of number. As stated above, these stimuli were argued to have similar figural properties and therefore it was hoped that this would help reduce strategy use. The elements in the stimuli were also close together and the overall figure subsumed an angle of less than 10 degrees. Furthermore, all stimuli were proportionally the same size and used the same size font. All letters and numbers were printed in black on a white background.

4.2.3 Design

The CSA-WA experiment was a 2 x 2 design with stimuli (global or local) and the test session (session 1 or session 2) both being within subject factors. The WA-IT was also a 2 x 2 design with stimuli (wholistic, analytic) and session (1, 2) being the within subjects factors.

Each stimulus type in the WA-IT was presented twice at each duration (12.5, 19, 25, 31, 37.5, 44, 50, 56, 62.5, 81, 100, 200, 400, 600 ms) using the method of constant stimuli. Therefore, at each of the fourteen durations, eight global and eight local stimuli were presented giving a total of 224 stimulus presentations. The order of stimuli and the duration they were presented in was randomised by the computer with the requirement that each stimulus type was presented twice at each duration.

4.2.4 Procedure

Participants were tested individually in a quiet room. The CSA-WA was administered first followed by the WA-IT.

For the CSA-WA task, participants were given the same instructions and followed the same procedure as that set out in the Cognitive Style Analysis Administration manual (Riding, 1998) (see Chapter 3 for more details).

In the WA-IT task, participants were presented with instructions and then 10 practice trials at varying durations (all of which were greater than 300ms). The instructions explained that the task required them to identify whether they saw an 'E' or an 'F'. Subjects were informed that before each stimulus was presented, they would be presented with a prompt (of 1sec duration) which told them to either "Look Global" or "Look Local", this would be followed by a central "+" (of 1 sec duration), then a stimulus (12-600 ms duration) and finally a mask (of 1 sec duration) and a screen asking them to respond (no time limit) (see Figure 4.7). If they were told to "look global", this would indicate that the global or big shape would be an 'E' or an 'F' (e.g., Figure 4.5). If they were told to "look local" this would indicate that the local letters would be Es or Fs (e.g., Figure 4.6). Examples of each possible stimulus were given (e.g., Figures 4.5 and 4.6). Finally, subjects were reminded that despite the fact that each stimuli consisted of one letter and one number, the answer could only be an E or an F. Responses were made on a button box which had two buttons, one labelled 'E' and the other 'F'.

The inspection time version of the wholistic-analytic test was divided into five sections with section 1 being a practice section. Participants were instructed to take a break before continuing on to the next section. For most participants this meant a break every five minutes except for the practice that took approximately 1 minute to complete.

A session involved completing CSA-WA and the WA-IT with approximately a 5-minute break between each test. The same procedure was repeated approximately a week later.

4.3 Results

4.3.1 The CSA wholistic-analytic task (CSA-WA task)

The mean, median and standard deviations of the reaction times for the wholistic and analytic sections of the CSA at session 1 and session 2 are presented in Table 4.1 below. Note that reaction times on the wholistic and analytic sections of the test decrease with practice, i.e., at session 2, but this difference was only significant for the wholistic task ($F[1,38] = .698$, $p = .012$). Furthermore, people appear to be faster on the analytic task than the wholistic task ($F[1,78] = 32.5$, $p < .001$). This may reflect the fact that the wholistic section was administered first and the analytic section last.

The reliability of the CSA-WA over time

Correlations between subjects' session 1 and session 2 wholistic and analytic median reaction times were high (wholistic $r = .84$, $p < .001$; analytic $r = .74$, $p < .001$). In keeping with Riding's (1991) formula for allocating a style category, a ratio of each subject's average response time on the wholistic to the analytic dimension was taken. The correlation between session 1 and session 2 wholistic-analytic ratios remained high ($r = .706$, $p < .001$). The

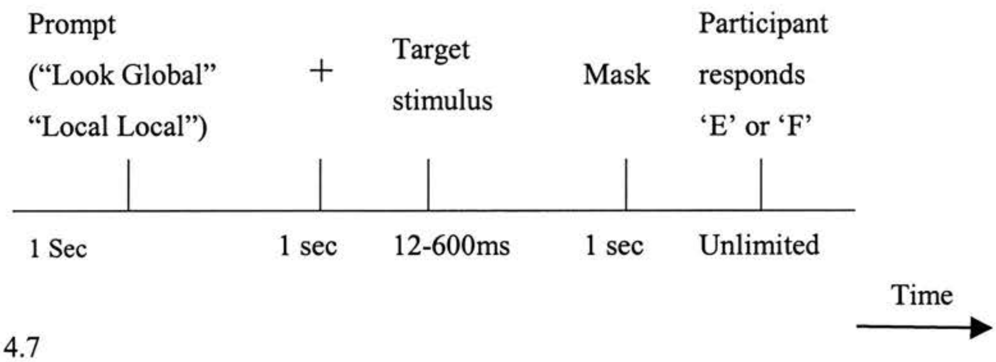


Figure 4.7

The temporal order of the sections in the WA-IT task

Table 4.1

Descriptive statistics for the participants' reaction times (RT) in ms on the CSA-WA test (N= 20)

	Session 1	**Session 2**
Wholistic RT		
Mean	1487	1216
Median	1417	1107
Standard Deviation	487	364
Analytic RT		
Mean	1367	1184
Median	1362	1095
Standard Deviation	335	295

value of each participant's ratio was then associated with a particular style category and the degree of agreement between the session 1 and session 2 style categories was calculated. The results found that the style categories also appeared to be reliable over time ($r = .684$, $p = .001$).

4.3.2 Wholistic-analytic inspection time task (WA-IT task)

Descriptive statistics

The percent of global and local items that were correctly identified at the different durations across all subjects is shown in Figure 4.6. The figure suggests that, as the exposure duration of the stimulus increases, accuracy reaches 100 %. Figure 4.6 also shows the performance on the local task is on average less accurate than performance on the global task, but this difference is reduced as the exposure duration increases. Figures 4.7 and 4.8 show the standard errors for the percentage of local and global items that were identified correctly at the different durations. Both figures show responses were more varied on the smaller durations than on the longer durations, and responses on the local items appears to be more variable than the responses on the global items. Figure 4.9 compares the responses on the global and local items at session 1 and 2. The figure indicates that performance on local items at session 1 and session 2 is similar and overall, it is less accurate than the performance on global items at session 1 and session 2.

The pattern of each subject's responses to the global and local items at each session was examined in order to see whether subject response patterns differed (see Appendix 2). It appears that there is considerable variation in the subjects' response patterns to the global and local stimuli. Notably some subjects found the local items especially hard to correctly identify compared to the global items (e.g., subject 8 on session 1 and 2), whereas other subjects appear to perform equally well on the local and global items (e.g., subject 16 on session 1 and 2).

A 2 x 2 (stimulus type, session) analysis of variance was performed on the subjects' total number of correct items in the WA-IT task. Stimulus type (global and local) and session (1 and 2) were the within subject variables.

A strong main effect was found for stimulus type ($F[1,76] = 4.246$, $p < .001$, eta squared = .31) with global items being easier to recognise than local items and a weaker main effect

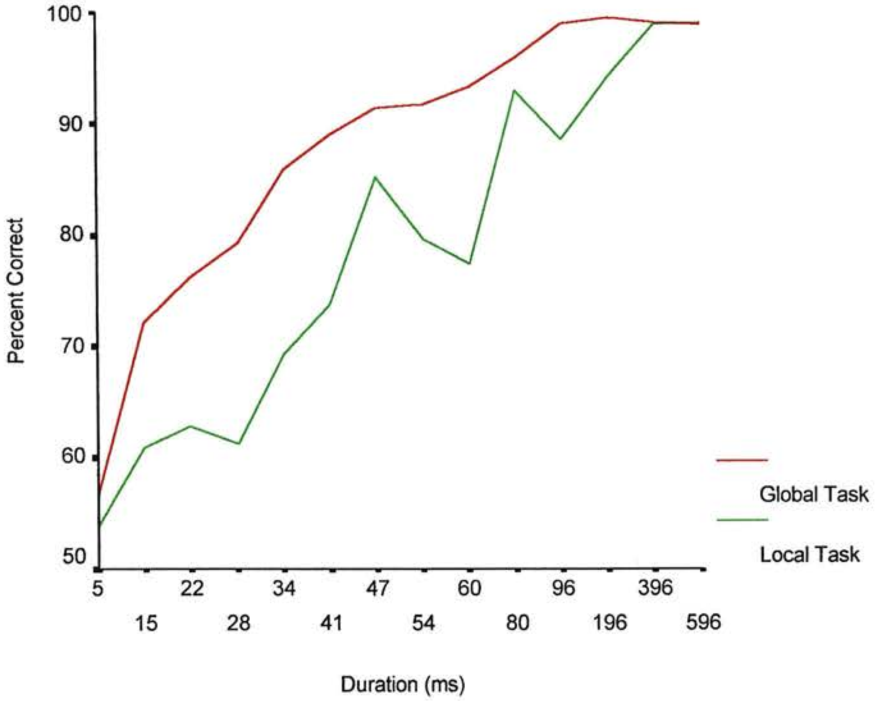


Figure 4.6
Percentage of global and local items correctly identified at each exposure duration in the WA-IT task

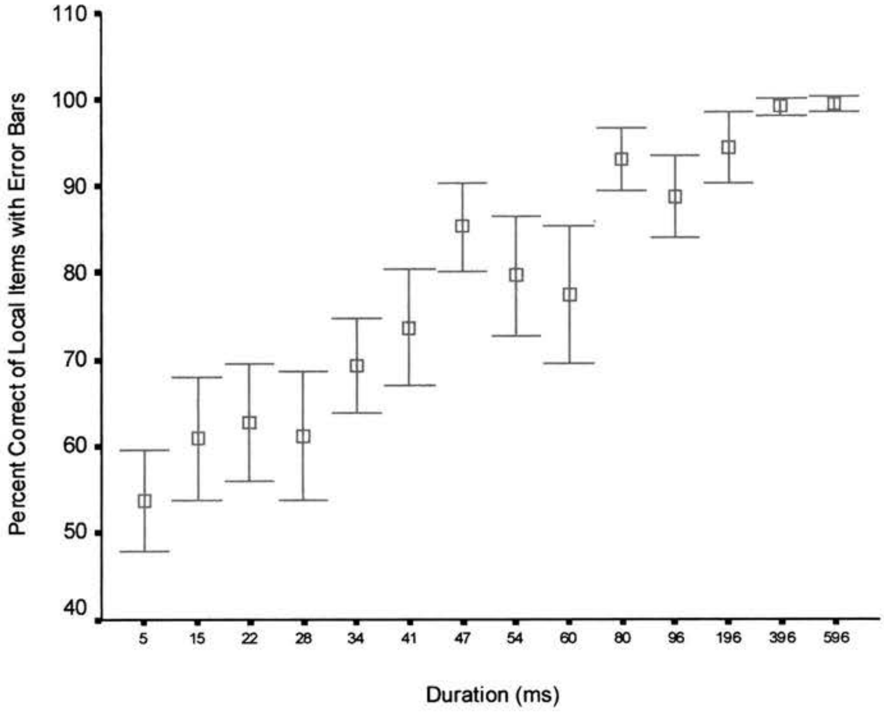


Figure 4.7
Graph showing the percent correct and error bars at each duration (ms) for the local stimuli in the WA-IT task

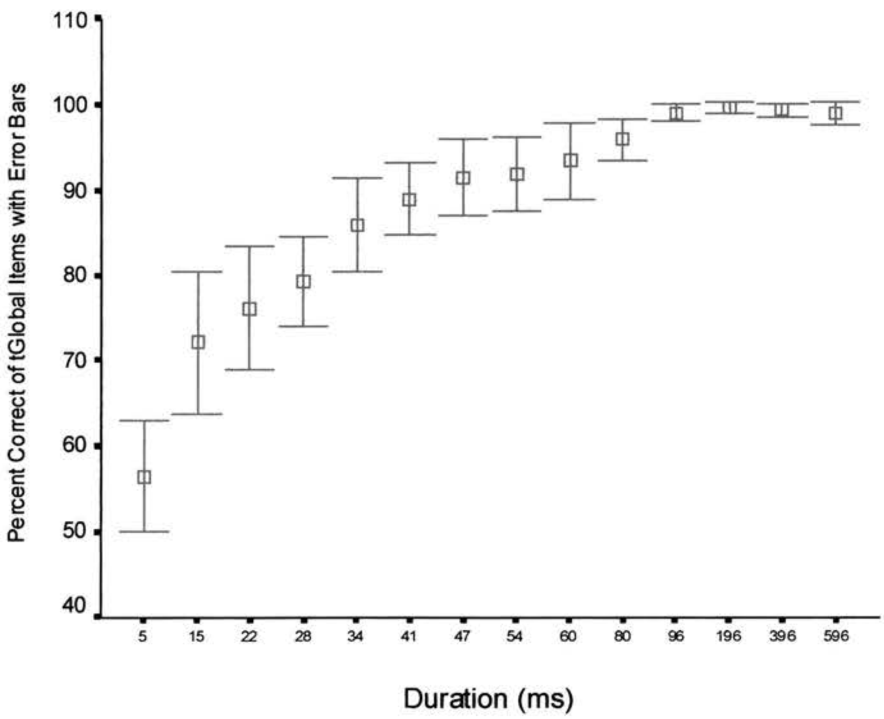


Figure 4.8
Graph showing the percent correct and error bars at each duration (ms) for the global stimuli in the WA-IT task

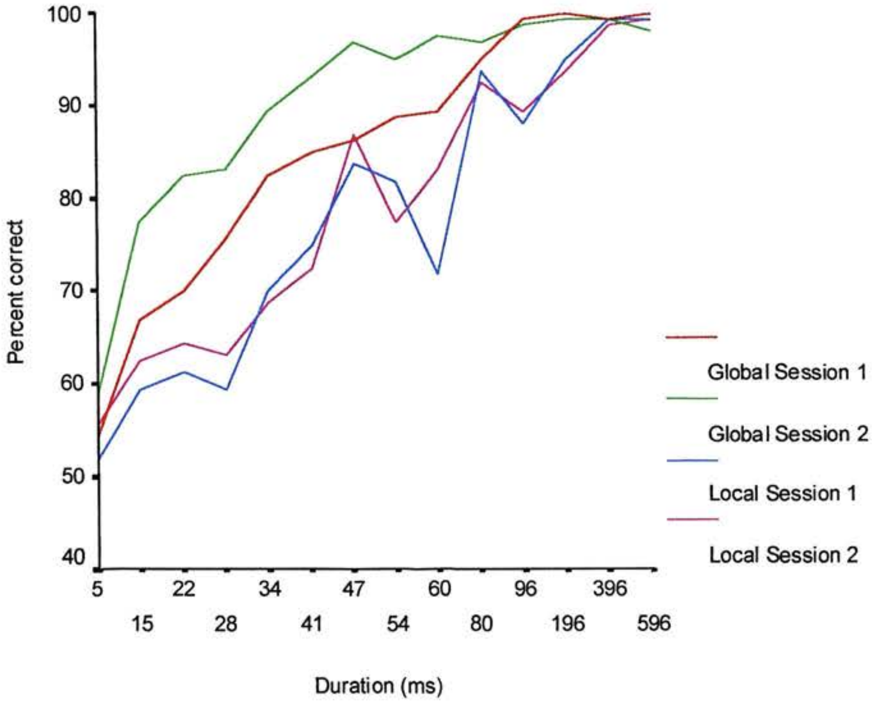


Figure 4.9
Percentage of global and local items that were correctly identified at each duration for each session on the WA-IT task

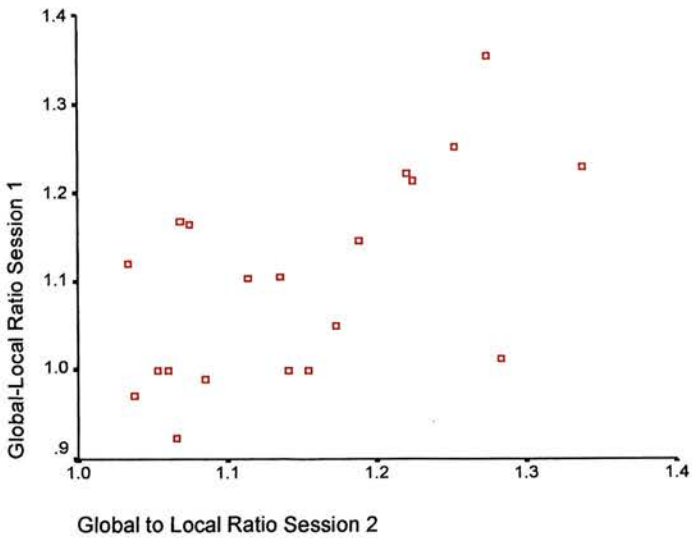


Figure 4.10
Scattergram of the correlation between the global to local ratios at session 1 and session 2

was found for session (F [1,76] = 4.246, p <.043, eta squared = .053) with session 2 performance being slightly better than session 1. No significant interaction was found.

The reliability of the WA-IT over time

To examine whether individual differences in subject performance on the global and local items were similar at session 1 and session 2, the total number of correct items at session 1 was correlated with the total number of correct items at session 2 for each item type (global and local). The correlations between the global accuracy scores at session 1 and session 2 and the local accuracy scores at S1 and S2 were high (global S1-S2 r = .84, p <.001; local S1 –S2 r = .76, p = .001).

In keeping with the CSA's calculation of cognitive style, a ratio of global to local scores was taken at each session. Figure 4.10 above shows a scattergram of the correlation between the global and local ratios at session 1 and 2. The scattergram indicates the presence of some outliers but the majority of the participants seem to perform consistently over time. The correlation between the global-local accuracy ratios at session 1 and session 2 was r = .60, p <.001.

4.3.3 Comparisons between the CSA-WA and the WA-IT

Correlations between the CSA-WA median reaction time scores and the WA-IT accuracy scores are shown in Table 4.2 below. The correlations between the CSA-WA and the WA-IT are low, negative and non significant (less than -.3), whereas the correlations within each test are high (above r = .7). Despite the correlations between the CSA-WA and the WA-IT being non-significant, they are in the expected direction, with the quicker (and therefore lower) response times on the CSA-WA corresponding negatively, with the higher accuracy scores on the WA-IT.

Correlations between the CSA-WA ratios and the WA-IT ratios were also conducted. The results can be found in Table 4.3 below. It shows that the correlations between the ratios within each test are significant and acceptable. However, the correlations between the test's ratios (CSA-WA ratio and WA-IT ratio) although in the expected direction, remain weak and non-significant (less than -.32). The session 1 and 2 inspection time data was then combined and the ratios were recalculated to see whether an inspection time ratio based on a larger number of trials would change the degree of correlation between the CSA-WA ratios and the

Table 4.2
Correlations (p values) between subjects' median reaction times on WA-RT task and subjects' number of correct global and local items on the WA-IT task. For all correlations N= 20. Items in bold show the correlations with each test type.

	1	2	3	4	5	6	7
1. WA-IT, Global, S1							
2. WA-IT, Global, S2	**.842** (.000)						
3. CSA-WA, Wholistic, S1	**-.109** (.647)	**.-215** (.362)					
4. CSA-WA, Wholistic, S2	**-.175** (.461)	**-.205** (.385)	**.842** (.000)				
5. WA-IT, Local, S1	.412 (.071)	.445 (.050)	.296 (.205)	.348 (.132)			
6. WA- IT, Local, S2	.497 (.026)	.596 (.009)	.037 (.876)	.082 (.732)	**.757** (.000)		
7. CSA-WA, Analytic, S1	-.266 (.257)	-.331 (.154)	.676 (.001)	.579 (.007)	**-.014** (.954)	**-.098** (.683)	
8. CSA-WA, Analytic, S2	-.101 (.673)	-.222 (.347)	.585 (.007)	.718 (.000)	**.252** (.284)	**.160** (.501)	**.742** (.000)

Table 4.3:
Correlations (p values) between the CSA-WA ratios and the WA-IT ratios at session 1 and session 2. (N = 20). Items in bold show the correlations within each test type.

	1	2	3
1. Ratio WA-IT, S1			
2. Ratio WA-IT , S2	**.595** (.006)		
3. Ratio CSA-WA, S1	-.319 (.170)	-.223 (.344)	
4. Ratio CSA-WA, S2	-.310 (.184)	.032 (.894)	**.706** (.001)

combined WA-IT ratios. However, the combined session 1 and session 2 WA-IT ratios did not correlate significantly with the CSA-WA ratios ($r = < -.32$).

4.4 Discussion

4.4.1 Reliability of the WA-RT and the WA-IT tasks

The results of this experiment suggest that there are reliable individual differences in the time taken to respond to wholistic and analytic items on the CSA-WA and reliable individual differences in response accuracy to the different exposure durations on the global and local items of the WA-IT. However, correlations between the reaction times within the CSA-WA overtime and between the number of correct responses across all exposure durations within the WA-IT over time are not the key variables of interest, as they tell us nothing about relative style preferences. To examine style preference on the CSA-WA, a wholistic-analytic ratio was calculated and found to be stable over time ($r = .71$, $p = .001$). The WA-IT ratio was weaker ($r = .60$, $p = .006$), but still encouraging especially given the low number of trials ($N = 224$). No significant correlations were found between the CSA-WA ratios and the WA-IT ratios which suggests that the two tests may have been tapping into different wholistic-analytic preferences.

However, the results of this study need to be treated with caution. With only 20 participants, this pilot study had power of less than .5 to detect a medium effect size. Given that adequate power is usually considered to be 80% or above, this study needs to be repeated on a larger sample before the results can be generalised. A sample of 40 participants would normally be needed in this experiment to detect an effect size of .5 with 80% power.

Nevertheless, the results are promising as they indicate that the original CSA-WA (i.e., not the Extended form of the WA dimension) may be more reliable than first thought (see Chapter 3)[4] and it looks like there could be reliable individual differences in the local-global advantage with the WA-IT being moderately stable. However, due to the small sample size, the confidence intervals around the correlated values (r) are likely to be high and therefore the results need to be viewed with caution.

---

[4] Note this experiment was conducted before it was realised that the doubling the length of the wholistic-analytic (WA) dimension improved the reliability of the CSA's WA dimension (see Chapter 3). Therefore, the Extended CSA-WA test was not used in this study.

The low correlations between the CSA-WA ratio and the WA-IT ratio suggest that the two tasks are not measuring the same thing. This finding is interesting as both the ratios appeared to be reasonably reliable over time, but what they were measuring may well have been different. The low power of this study means that this would need to be confirmed on a larger sample.

Contrary to what was expected, there seemed to be a global advantage effect for all but two subjects (subjects 12 and 14 in session 1). This suggests that the stimuli that were used in the WA-IT were not sufficiently neutral to allow some subjects to perform better at the global task and others to perform better at the local task. Although it was hoped that using neutral Navon stimuli would allow individual differences in local and global preferences to be found, this finding is not necessarily critical as the results can be analysed to look for individual differences in the degree to which subjects were affected by the global advantage. At this stage, it appears that there might be stable individual differences in the degree to which an individual is affected by the global advantage but these findings would need to be repeated on a large sample with more trials.

4.4.2 Limitations with the study

As noted above, a limitation of this pilot study is the small number of participants involved resulting in the study having low power. Another problem is that there were only two trials of each stimulus type at each of the stimulus durations on the WA-IT task. This may have been too small to pick up subtle individual differences. Typically, inspection time tasks have multiple trials at each duration in order to reduce the possibility that participants were responding accurately by chance. Unfortunately, it is difficult to make the task longer as the subjects already found the current task repetitive and so adding more stimuli and more trials to one session is impractical. Future studies may like to look at subject performance over a period of several days.

In conclusion, these results suggest that there could be stable individual differences in performance on the WA-IT task and this finding is worth further investigation with a larger sample completing a greater number of trials. However, as the CSA-WA and the WA-IT did not significantly correlate, this line of enquiry could not be developed further in this thesis.

The next chapter will outline the design of a new verbal-imagery cognitive style test and investigates whether it is stable over time.

Chapter 5

The Design and Development of the Verbal Imagery Cognitive Styles (VICS) Test

5.1 Introduction

5.1.1 The verbal-imagery dimension revisited

Chapter 2 outlined the CSA test's popularity and gave an overview of some of the studies that support its claim of empirical validity. Chapter 3 showed that despite the CSA's popularity it is not a reliable or internally consistent measure of cognitive style. More specifically, the verbal-imagery section of the CSA had a test-retest reliability of approximately .2 and the wholistic-analytic dimension a test-retest reliability of about .4. Chapter 3 also investigated what would happen if the CSA test were doubled in length. The results indicated that doubling the length of the wholistic-analytic dimension increased its internal consistency to approximately .7; however, doubling the test length of the verbal-imagery dimension of the CSA did not lead to an improvement. Two possible explanations for the continued instability of the verbal-imagery dimension of the CSA were given. First, stable individual differences on the verbal-imagery dimension may not exist or may be weaker or more volatile than individual differences on the wholistic-analytic dimension. Alternatively, the CSA test items may be inappropriate for detecting verbal-imagery style differences. This chapter describes a study that investigates the latter suggestion by examining whether a reliable verbal-imagery style preference can be measured using different stimuli and a different research design from the CSA. A description of the verbal-imagery section of the CSA test (CSA-VI) and potential problems with its design are given. A description of the new Verbal Imagery Cognitive Styles (VICS) test and how it overcomes some of the CSA-VI's design limitations follows this.

The CSA's verbal-imagery test

The CSA is a computerised test which assesses verbal-imagery cognitive style by comparing the time participants take to answer questions comparing the categories of two objects (e.g., "Are Skiing and Cricket the same type?") which is a verbal task, to the time taken to compare the colour of two objects (e.g., "Are Mud and Chocolate the same colour?") which is an imagery task. Participants are told after each response whether their answer is correct or incorrect. The ratio of the participant's average verbal reaction time to their average imagery reaction time is then calculated and the value of this ratio compared to a set of style norms associated with particular style types (verbal, bimodal, imagery).

5.1.2 Limitations of the CSA's verbal-imagery test

Comparisons of type and colour

Few objects in the world are exactly the same type or colour. For example, according to the CSA the answer to the verbal question "Are Chicken and Beans the same Type?" is "Yes" because chicken and beans are both food. However, if the participant categorises a chicken as an animal and beans as vegetables, then they would not be the same type. Therefore, the participant might answer "No", to which the computer would respond "incorrect". Similarly, the answer to the imagery question "Are Chocolate and Mud the same colour?" is, according to the CSA, "Yes". Chocolate and mud, however, are not always brown and therefore not always the same colour. Hence, on some of the verbal and imagery items the correct answer is not always obvious to the respondent.

Sensitivity of the participants

The subjective nature of some of the verbal and imagery stimuli used in the CSA test may negatively affect individuals who are extreme verbalisers or extreme imagers. For example, extreme verbalisers may be more precise with their judgements on category type (verbal stimuli) and extreme imagers may be more precise with their colour judgements (imagery stimuli). As a result, these participants may respond more slowly on their preferred dimension. This could adversely affect the CSA test's assessment of their style because the CSA calculates style based on the assumption that people process the stimuli from their preferred dimension faster. Furthermore, if people's extreme styles make them more precise, they are more likely to make decisions which are labelled as "incorrect" by the test and this negative feedback may further increase their average reaction time on their preferred dimension.

Format of the items

The CSA tests the verbal-imagery dimension using items presented in words. Riding (1991, 1998) argues that this is to control for different reading speeds. However, there is no way of knowing if a participant on the imagery task actually creates a mental image in order to compare the colour of two items. Instead, some participants may use semantic information about the objects to compare the colours. This strategy would largely defeat the purpose of the imagery task. Therefore, a task that tests participant responses to images and words (rather than relying on the words to provoke an image) may be a more appropriate and more effective way of tapping into verbal and imagery cognitive style preferences.

The current experiment proposes that the new Verbal Imagery Cognitive Styles (VICS) test is potentially an improved measure of verbal-imagery style for three main reasons. Firstly, the VICS does not use subjective questions about the colour and type of objects. Secondly, by having less ambiguous questions, the VICS avoids the potential problem of people with strong style preferences taking more time to answer questions. Thirdly, it uses word and picture stimuli to test each style dimension rather than just words.

5.1.3 The new verbal imagery cognitive styles (VICS) test

As mentioned above, to assess the verbal dimension of cognitive style, Riding's (1991, 1998) CSA test asks the categorisation question "Are X and Y the same Type?" The new VICS test proposes that a more appropriate categorisation or verbal dimension question is one where the participants are asked to determine whether two items are man-made or natural. Other categorisation distinctions were considered such as an abstract and concrete (e.g., Gordon, 1961), or living and non-living (e.g., Garrard, Lambon Ralph, Hodges, Patterson, 2001). However, these categorisations are unsuitable for the present experiment because abstract words are difficult to draw clearly and the definition of what counts as living is varied. For example, people may differ as to whether they think a carrot not in the ground is living or whether living implies sentient etc. To reduce confusion, any experiment wanting subjects to make a distinction between living and non-living objects would need to be confined largely to animal stimuli. This makes the number of stimuli available too small for the present study. The advantages of the natural/manmade distinction used in the VICS are that it allows the experimenter to use a wide variety of objects that can be easily identified when drawn, and the distinction between what generally occurs naturally versus what is man-made is easy with an appropriate choice of common objects.

Riding's (1991, 1998) CSA assesses the imagery dimension by asking the question "Are X and Y the same colour?" The new VICS suggests that a more suitable task (which is based on Paivio's [1975] experiment) is to present participants with two objects and ask them to judge which object is bigger. There are two major advantages of this task. Firstly, objects can be chosen which are clearly different sizes in real life. Secondly, the same verbal stimuli (i.e., natural and man-made objects) that are used in the verbal task can be employed for the size judgement (imagery) task. Using the same stimuli in the verbal and imagery tasks also prevents the need to control for differences between the verbal and imagery tasks in word agreement (the degree to which an image provokes a particular word), image agreement (the degree to which a word provokes a specific image), word frequency and word familiarity.

Another potential advantage of the VICS over the CSA's verbal-imagery test is that the verbal section of the VICS task ("Are X and Y natural?") and the imagery section of the VICS task ("Is X bigger than Y?") both present X and Y in a picture format and in a word format. Therefore, every item is presented twice in each section of the task, once with X and Y as pictures and once with X and Y as words. This enables the experimenters to look at whether style preferences occur not only across the verbal and imagery tasks, but also between the pictures and words within a task.

One potential problem with investigating if there are individual differences in the processing of pictures and words is that there is considerable evidence that pictures are automatically processed faster than words (Paivio & Begg, 1974; Fraisse, 1968; Paivio, 1975). There is however, some evidence to suggest that, in categorisation tasks, there is no difference in the speed of processing pictures or words (Smith & Magee, 1980). Therefore, it is important to have an experiment that allows this potential picture bias to be investigated without necessarily interfering with the overall purpose of comparing an individual's performance on the verbal and imagery tasks.

In summary, this study will investigate whether the VICS task is a more reliable measure of verbal-imagery cognitive style than the CSA's verbal-imagery (CSA-VI) dimension. The main advantages of the VICS over Riding's (1991, 1998) CSA-VI are hypothesised to be: less subjective categorisations are required in the verbal and imagery questions; use of the same stimuli in both tasks allows for a closer comparison between the two tasks; use of pictures and words to examine style preference as opposed to just words (Riding, 1991, 1998, uses only words); and greater control over the word frequency, image agreement and name agreement between the two tasks.

In order to investigate whether the VICS is more stable and reliable than the CSA-VI, participants will be required to complete both tests twice; the second sitting occurring approximately a week later. It is hypothesised that performance on the VICS will be more reliable and internally consistent over time than performance on the original and a parallel version of the verbal-imagery dimension of the CSA.

5.2 Method

5.2.1 Participants

There were 50 participants in the study and the majority of them were students from the University of Edinburgh. The mean age of participants was 27 years (SD = 8.8; Range 18-59) and the average number of years of education was high (M = 17, SD = 2.7, Range = 10-25). All of the participants spoke English as their first language, and the majority of them were right handed (84%).

5.2.2 Apparatus

Three E-PRIME programs were created to present and record the temporal parameters of the tasks. Task 1 was the newly designed VICS test. Task 2 was an exact copy of the original verbal-imagery dimension of Riding's (1991, 1998) CSA test (CSA-VI-A), and task 3 was designed to be a parallel version of the verbal-imagery dimension of Riding's CSA test (CSA-VI-B).

5.2.3 Stimulus materials

The stimulus materials for the CSA-VI-A and the CSA-VI-B were exactly the same as those reported in Chapter 3.

All the stimuli for the VICS test consisted of a question about two objects. The objects used (e.g., chair, church etc.) were the same in both the verbal section of the VICS and the imagery section of the VICS. The sections of the test differed only in the type of question asked about the two objects.

The verbal section of the VICS task required participants to state whether they thought two objects were natural, man-made or a mixture (i.e., where one object is man-made and the other is natural). All the questions took the form "Are X and Y natural?" to which the participant could respond "Yes", "No" or "Mixed". For example, the answer to the question "Are Butterfly and Penguin natural?" was "Yes", the answer to the question "Are Toaster and Screw natural?" was "No", and the answer to the question "Are Pineapple and Guitar natural?" was "Mixed". Each stimulus was presented in a word form and a picture form (see Figures 5.1 and 5.2 below) and in keeping with Riding's CSA, feedback on correctness was given after each response.

The imagery section of the VICS task required participants to state whether the first object in a pair was bigger, smaller or approximately the same size in real life as the other object in the pair. All the stimuli took the form "Is X bigger than Y?" to which the participants could answer "Yes", "No" or "Equal". For example, the answer to "Is Toaster bigger than Screw?" was "Yes", the answer to "Is Butterfly bigger than Penguin?" was "No" and the answer to "Is Apple bigger than Onion?" was "Equal". Like the verbal section, each stimulus was presented in a word form and in a picture form (see Figures 5.3 and 5.4).

Table 5.1 shows which items the experimenter identified as man-made, natural or mixed and whether the first item in the pair was identified by the experimenter as smaller, bigger or equal sized with the second item in the pair.

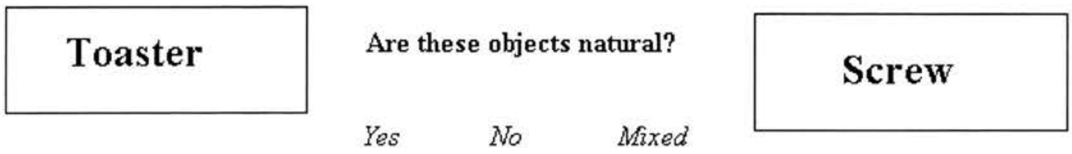


Figure 5.1
Example of the same verbal item in the word form

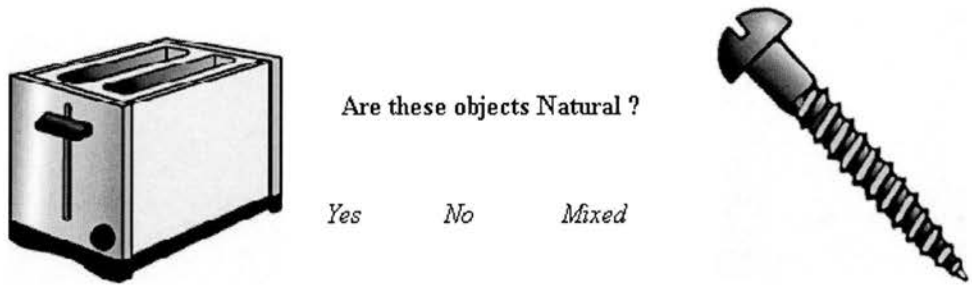


Figure 5.2
Example of the same verbal item above in the picture form

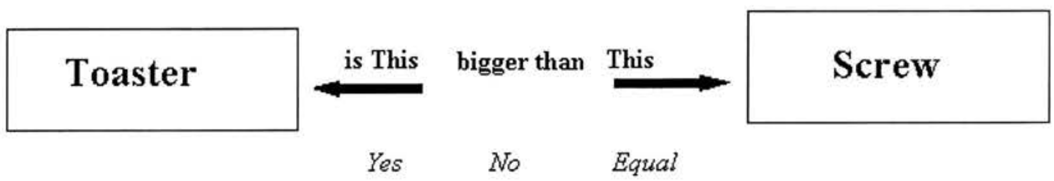


Figure 5.3
Example of an imagery item in the word form

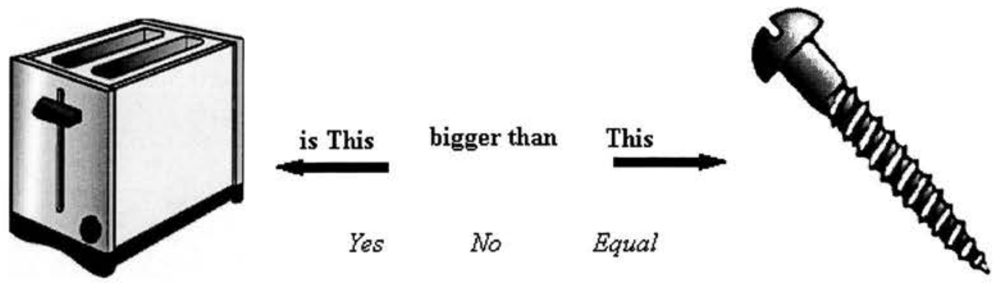


Figure 5.4
Example of the imagery item above in the picture form

Table 5.1

The VICS items used in the verbal and imagery task and the category with which they were associated.

ITEMS		Natural	Man-Made	Natural & Man-made	1=1st item smaller 2 = 2nd item bigger 3 = Equal size
Man-made					
Ashtray Snowman	1		*		1
Balloon Ladder	2		*		1
Cup Bed	3		*		1
Belt Barrel	4		*		1
Key Bottle	5		*		1
Bowl Anchor	6		*		1
Broom Envelope	7		*		2
Bus Chain	8		*		2
Candle Wheel	9		*		1
Chair Sock	10		*		2
Crown Scissors	11		*		2
Lamp Ring	12		*		2
Bell Cannon	13		*		1
Flag Button	14		*		2
Bread whistle	15		*		2
Kite Glove	16		*		2
Hat Guitar	17		*		1
Harp Helicopter	18		*		1
Shoe Sled	19		*		1
Drum Comb	20		*		2
Screwdriver Skirt	21		*		1
Stool Ruler	22		*		2
Swing Spoon	23		*		2
Man-made Equal Size					
Pen Fork	24		*		3
Sock Glove	25		*		3
Pencil Toothbrush	26		*		3
Natural					
Penguin Butterfly	1	*			2
Flower Camel	2	*			1
Duck Carrot	3	*			2
Ostrich Turtle	4	*			2
Dog Tree	5	*			1
Cow Thumb	6	*			1
Fish Lion	7	*			2
Foot Giraffe	8	*			1
Bear Peanut	9	*			2
Giraffe Grapes	10	*			2
Tree Penguin	11	*			2
Lemon Kangaroo	12	*			1
Lips Squirrel	13	*			1

Table 5.1 continued

ITEMS		Natural	Man-Made	Natural & Man-made	1=1st item smaller 2 = 2nd item bigger 3 = Equal size
Natural					
Owl Nose	14	*			2
Pear Monkey	15	*			1
Strawberry Pineapple	16	*			1
Eye Pumpkin	17	*			1
Banana Rabbit	18	*			1
Snake Thumb	19	*			2
Cat Mushroom	20	*			2
Turtle Potato	21	*			2
Ear pear	22				1
Owl Lemon	23	*			2
Natural Equal Size					
Apple Onion	24	*			3
Rabbit Duck	25	*			3
Zebra Horse	25	*			3
Mixed Category					
Screw Frog	1			*	1
Pineapple Guitar	2			*	1
Nose Ladder	3			*	1
Umbrella Peanut	4			*	2
Tiger Balloon	5			*	2
Cat Hammer	6			*	2

Repeated items

Man-made Items: Ladder, guitar, sock, glove, sled

Natural Items: Owl, Turtle, peanut, penguin, giraffe, pineapple, rabbit, duck, cat, thumb, nose

Nb. All stimuli that are repeated appear once on the left and once on the right.

A total of 232 stimuli (116 in the verbal section, 116 in the imagery section) were constructed and presented in the test. Out of the 116 stimuli in each task, 58 of them were presented in words and the same 58 stimuli were also presented in pictures. From the 116 stimuli in each task, 52 stimuli (26 in the word form and 26 in the picture form) were both natural, or presented the bigger item first, and 52 stimuli (26 in the word form and 26 in the picture form) were both manmade, or presented the smaller item first, and 12 of the stimuli (6 in the word form, 6 in the picture form) were mixed stimuli (one natural, one man-made), or approximately the same size.

The objects used in the verbal and imagery section of the VICS were all chosen from Rossion and Pourtois (2001) coloured images, which in turn were based on Snodgrass and Vanderwart's (1980) earlier black and white drawings. These images have been drawn to precise guidelines in terms of style and orientation. The Snodgrass and Vanderwart images have also been normed for name and image agreement, familiarity and complexity and where possible, age of acquisition and frequency. Using the Snodgrass and Vanderwart norms (norms for Rossion & Pourtois colour stimuli are currently being developed), an analysis of the natural, manmade and mixed stimuli groupings in the verbal section were found to have similar means, ranges and standard deviations for name and image agreement, frequency, familiarity and age of acquisition (see Table 5.2). No significant differences were found between the man-made or natural stimuli for any of the above factors except complexity.[1] Natural objects were found to be more complex than man-made objects ($\underline{F}$ [2,113] = 9.817, $\underline{p}$ <.001). The significant difference in the complexity between the man-made and natural objects suggests that man-made objects such as a box or a spoon typically are perceived as simpler than natural objects such as cat or a foot, which are detailed and intricate.

Similarly, the bigger, smaller and equal-sized stimuli groupings in the imagery section of the test were found to have similar means, standard deviations and ranges for name and image agreement, frequency and age of acquisition (see Table 5.3). No significant differences were found between the bigger, smaller and equal sized items on these factors. There was however, a significant difference between the familiarity and the complexity of big, small and equal sized labelled objects (complexity $\underline{F}$ [2,113] = 9.47, $\underline{p}$ <.001; familiarity $\underline{F}$ [2,113] = 6.17, $\underline{p}$ =.003). On examination of the means these effects suggest that larger objects are typically more complex (e.g., a tree is more complex than a leaf), and less familiar objects (in terms of degree of contact) are often larger. For

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[1] Complexity is a measure of how intricate or detailed an object is.

example, it is not often that people come in to contact with helicopters, lions or camels, which are used in this experiment as large objects.

In summary, the above findings show that any differences in participant performance on the verbal and imagery tasks and any differences in responses to particular types of stimuli within each section of the test (man-made, natural, mixed, bigger, smaller or equal) are unlikely to be due to differences in name and image agreement, word frequency or age of acquisition.

Table 5.2

Table of the mean, median, minimum and maximum values for the name agreement (H), percentage name agreement (% of subjects giving the most common name); mean ratings of image agreement, familiarity and complexity; the Kucera-Francis frequency counts for each word name; and the Carroll-White age of acquisition norms for the concepts that were available and used in the verbal (man-made, natural, mixed) section of the VICS test. Note image agreement, familiarity and complexity all have the same rating scale (1 = low, 5 = high).

	Name Agmt	% Agreement	Image Agreement	Familiarity	Complexity	K-F Freq	Age of Acquisition
Man-made							
Mean	.12	97	3.91	3.45	2.60	20	3.11
Median	.16	98	3.95	3.45	2.50	14	3.12
Min	.00	88	2.85	1.52	1.42	0	1.66
Max	.49	100	4.85	4.85	4.25	127	5.41
N	58	58	58	58	58	58	25
Natural							
Mean	.16	96	4.00	3.13	3.31	21	2.91
Median	.16	98	4.07	3.00	3.38	9	2.75
Min	.00	86	3.12	1.52	1.15	0	1.36
Max	.53	100	4.62	4.88	5.60	122	5.12
N	58	58	58	58	58	58	32
Mixed							
Mean	.13	97	3.97	3.28	3.06	16	3.39
Median	.01	99	3.87	3.27	3.12	9.5	3.35
Min	.00	93	3.60	2.10	1.55	1.0	1.36
Max	.37	100	4.60	4.52	4.62	60	5.41
N	12	12	12	12	12	12	12

Note: Name Agmt = Name Agreement (H) (see appendix 3 for calculation); % Agreement = Percentage of subjects giving the most common name; Image Agreement = Image Agreement [scale 1(low), 5 (high)]; K-F Freq = Kucera Francis Frequency.

Table 5.3

Mean, median, minimum and maximum values for the name agreement (H), percentage name agreement (% of subjects giving the most common name); mean ratings of image agreement, familiarity, and complexity; the Kucera-Francis frequency counts for each word name; and the Carroll-White age of acquisition norms for the concepts that were available and used in the imagery (bigger, smaller, equal) section of the VICS test. Note image agreement, familiarity and complexity all have the same rating scale (1 = low, 5 = high).

	Name Agmnt	% Agreement	Image Agreement	Familiarity	Complexity	K-F Freq	Age of Acquisition
Small Items							
Mean	.15	96	4.02	3.61	2.50	22	2.74
Median	.16	98	4.10	3.55	2.38	10	2.64
Min	.00	90	2.92	1.70	1.15	0	1.36
Max	.48	100	4.85	4.88	4.35	122	5.12
N	52	52	52	52	52	52	24
BigItems							
Mean	.15	96	3.89	2.91	3.36	18	3.20
Median	.08	98	3.90	2.80	3.5	9	3.04
Min	.00	86	2.85	1.52	1.15	0	1.36
Max	.53	100	4.62	4.72	5.6	127	5.41
N	52	52	52	52	52	52	28
Equal Items							
Mean	.09	97	3.93	3.57	3.14	19	3.09
Median	.00	98	.372	3.46	3.08	10	2.67
Min	.00	88	3.22	.74	1.60	1.	2.24
Max	.32	100	4.40	.31	4.68	117	4.83
N	12	12	12	12	12	12	5

Note: Name Agmnt = Name Agreement (H); % Agreement = Percentage of Name Agreement; Image Agreement = Image Agreement; K-F Freq = Kucera Francis Frequency

5.2.4 Design

In studying the reliability of a psychological measure, it is appropriate to power the study to detect coefficients in excess of about .5. Coefficients below that would indicate poor reliability. Thus with alpha set at .05 (2 tailed) and with $r = .5$, this study was designed to have a power of 96%. Adequate Power is usually considered to be 80% or above. The study had 80% power to detect an effect size of .39, which is well below the value that would indicate a reliable test.

This experiment was designed to investigate: firstly, whether participants' performances on the VICS and the verbal-imagery dimension of the original CSA (CSA-VI-A) and the verbal-imagery dimension of a parallel form of the verbal-imagery dimension of the CSA (CSA-VI-B) were stable over time; and secondly, whether participants' style ratio on the VICS was similar to their style ratio on the original and parallel form of the verbal-imagery dimension of the CSA. Therefore, a 2 x 2 (section of the test, session) within subjects analysis of variance was performed on the VICS, the CSA-VI-A and CSA-VI-B. The section of the test (verbal section, imagery section) and the test session (session 1, session 2) were both within-subject factors. All participants sat the VICS first, followed by the CSA-VI-A and the CSA-VI-B at both session 1 and session 2. The VICS presented the verbal section first and the imagery section second; however, the items within the verbal and imagery sections were presented in a pseudo-random order (more detail is given below). In keeping with Riding (1991, 1998), the CSA-VI-A and CSA-VI-B presented all verbal and imagery items together in a pseudo random order (see Chapter 3 for more detail).

The order of the stimuli in the verbal section of the VICS was randomised except for the following rule. Out of the 58 novel verbal stimuli, exactly half of them (29) were presented to the participant in the word form first e.g., 'toaster and screw' appearing as words. The remaining 29 stimuli in the verbal task were presented in the picture form first. Once all the 58 novel stimuli had been presented once (i.e., for the first exposure exactly half in word form and half in the picture form), the stimuli were presented again (second exposure) in their alternative form (i.e., all items that were presented first as words such as 'toaster and screw' were now presented in pictures and vice versa). The same procedure was used in the imagery section, except that the items that occurred first as words in the verbal section were presented first as pictures in the imagery section and vice versa. As a result of this procedure, the responses to all stimuli could be identified as falling into four categories: verbal first exposure; verbal second exposure; imagery first exposure; and imagery second exposure.

5.2.5 Procedure

Participants were tested individually in a quiet room. Each participant completed the VICS followed by the CSA-VI-A and the CSA-VI-B at both session 1 and session 2. Participants were told that none of the tests were measuring intelligence or ability. They were also told to work continuously, at their own rate and that they should try and be as accurate as possible.

A set of instructions was presented on the computer screen before each test. The instructions for the CSA-VI-A and CSA-VI-B were exactly the same as Riding's (1991, 1998) test. The instructions for the VICS were given before the verbal section and before the imagery section of the test and a practice session was also given following each set of instructions.

The VICS verbal instructions stated that the participants would be required to judge whether or not two items were natural, man-made or a mix (one natural and one man-made) and respond by pressing one of three buttons respectively. They were told that natural items were things that naturally occur in the environment e.g., ants, pigs, oranges, legs, eyebrows and grass. Man-made things were defined as objects that man has altered, in other words, the components may be natural but the end product is man-made for example, boats, fences, cigars, cakes, guns, and coins. Examples of natural, man-made and mixed stimuli were also given followed by six practice items.

The VICS imagery instructions stated that participants would be presented with pairs of words and asked the question "Is object X bigger than object Y?" They were told that for this task they were to imagine the objects as they occurred in everyday life. For example, in real life an 'elephant' is bigger than a 'mouse' so even if the mouse is drawn bigger than an elephant, the correct answer to "Is Elephant bigger than Mouse?" would be "Yes". Examples of items that were bigger, smaller and the same size were given followed by six practice items.

5.3 Results

Fifty participants were tested twice on both the VICS and on the CSA-VI-A and CSA-VI-B tests. In keeping with the original CSA criteria (Riding, 1998), two participants were excluded for having error rates of greater than 30% on both the VICS and the CSA. Therefore, all subsequent analyses, unless otherwise stated, were carried out on 48 participants.

5.3.1 Results of the verbal-imagery cognitive styles (VICS) dimension

Accuracy and reaction times were recorded for each test section (verbal, imagery), session (session 1, session 2), each stimulus form (pictures, words), and each stimulus exposure (verbal first exposure, verbal second exposure, imagery first exposure, imagery second exposure).

The mean, median and standard deviation of the reaction times for each test section, session, stimulus form, type of stimulus and stimulus exposure are reported in Tables 5.4–5.6.

The results from the analysis of variance (anova) are reported below, however it is important not to over-emphasise the anova results. The key variables of interest in this study are the consistency of the individual differences in reaction times and crucially the reliability of the reaction time ratios, not differences in overall reaction time means.

A main effect was found for test section (F [1, 47] = 10.32, p = .002, η^2 = .18), indicating that the imagery section of the test resulted in slightly slower reaction times than the verbal section of the test. A main effect was also found for session (F [1,47] = 116.7, p < .001, η^2 = .694), with performance at session 2 being faster than performance at session 1. Picture stimuli were responded to more quickly than word stimuli (F [1, 47] = 172.97, p < .001, η^2 = .786) and participants responded more quickly to the second exposure to a stimulus (F [1,47] = 120.5, p < .001, η^2 = .720).

A small interaction was also found between the section of the task (verbal, imagery) and the test session (1 or 2) (F [1, 47] = 5.35, p = .025, η^2 = .102). This effect is due to similar response speeds at session 1 on the verbal and imagery task, but at session 2 (where responses are faster overall), the verbal task appears to be conducive to proportionally quicker responses than the imagery task.

Stimulus exposure was also found to interact with 3 variables: task section, session and stimulus form. The interaction between stimulus exposure and task section was due to the second exposure to items in the verbal task resulting in faster response times than the second exposure to the items in the imagery task (F (1,27) = 9.759, p < .001, η^2 = .172). The interaction between stimulus exposure and session indicated that participants on session 1 benefited more from the second exposure to stimuli (i.e., they showed a greater decrease in reaction time to the second

Table 5.4

The means (M), medians (MD) and standard deviations (SD) of reaction times (ms) for the VICS test on each test section (verbal, imagery), each stimulus type (natural, man-made, mixed, bigger, smaller, equal), and at each session (1, 2). The answers to the questions (yes, no, mixed or equal) are also given. (N = 48)

Test Section	Stimuli Type	Answer	Session 1	Session 2
Verbal	Man-made	Yes	M = 2091 MD = 1733 SD = 1399	M = 583 MD = 1297 SD = 973
	Natural	No	M = 1704 MD = 1435 SD = 1020	M = 1319 MD = 1119 SD = 769
	Mixed	Mixed	M = 2225 MD = 1881 SD = 1303	M = 1775 MD = 1565 SD = 829
	Total		M = 1932 MD = 1599 SD = 1250	M = 1484 MD = 1239 SD = 887
Imagery	Bigger	Yes	M = 1917 MD = 1625 SD = 1149	M = 594 MD = 343 SD = 919
	Smaller	No	M = 2129 MD = 1781 SD = 1298	M = 1764 MD= 1449 SD = 1162
	Equal	Equal	M = 2114 MD = 1673 SD = 2247	M = 670 MD = 338 SD = 1568
	Total		M = 2032 MD = 1703 SD = 1371	M = 1678 MD= 1338 SD = 1115

Table 5.5

The means (M), medians (MD) and standard deviations (SD) of the VICS test for the pictures and words within each test section (verbal, imagery) and at each session (1, 2). (N = 48)

Test Section	Stimulus Form	Session 1	Session 2
Verbal	Picture	M = 1777 MD = 1473 SD = 1183	M = 1339 MD = 1122 SD = 789
	Word	M = 2086 MD = 1730 SD = 1295	M = 1629 MD = 1364 SD = 953
Imagery	Picture	M = 1897 MD = 1573 SD = 1200	M = 1500 MD = 1239 SD = 901
	Word	M = 2168 MD = 1827 SD = 1511	M = 1856 MD = 1538 SD = 1270

Table 5.6

The means (M), medians (MD) and standard deviations (SD) of reaction times (ms) on the VICS test for each stimulus exposure (first, second) within each test section (verbal, imagery) and at each session (1, 2). (N = 48)

Test Section	Stimulus Exposure	Session 1	Session 2
Verbal	First half	M = 2142 MD = 1802 SD = 1426	M = 1586 MD = 1339 SD = 947
	Second half	M = 1721 MD = 1435 SD = 1001	M = 1382 MD = 1157 SD = 809
Imagery	First half	M = 2160 MD = 1806 SD = 1521	M = 1752 MD = 1440 SD = 1273
	Second half	M = 1904 MD = 1586 SD = 1188	M = 1603 MD = 1334 SD = 925

exposure) compared to performance at session 2 when the task was no longer novel (F [1,47] = 26.2, $p < .001$, $\eta^2 = .362$). Finally, the interactions between stimulus exposure and stimulus form were due to a faster speed of response to the words at the second exposure compared to the pictures (F [1,47] = 23.15, $p < .001$, $\eta^2 = .330$).

A 3-way interaction was also found between stimulus exposure, form and task (F [1,47] = 20.73, $p < .001$, $\eta^2 = .299$). This interaction appeared to be underlined by the fact that performance on the pictures in the imagery task remained fairly constant at each exposure duration, whereas performance on the words in the imagery task and the words and the pictures in the verbal task resulted in a decrease in reaction time at the second exposure.

In summary, the most important initial reaction time results from the VICS are that participants respond faster on the VICS at session 2 than they do at session 1, faster on the second exposure to a stimulus than they did on the first exposure and pictures were responded to faster than words.

5.3.2 VICS: errors

In general, the number of errors made by each participant was very low (2.2% for the verbal section, and 3.0% for the imagery section). No significant differences were found in the number of errors made at each session and there was no significant difference in the number of errors made between the words and picture stimuli and between the first and second exposures to a stimulus (see Table 5.7).

The low error rate overall indicates that all participants understood the task and were well motivated. Note however, that this analysis excludes two participants who independently failed to meet Riding's (1998) criteria of a response accuracy of at least 70%.

Although the average number of errors made by subjects was low, some sections and items resulted in more errors than others. Significantly more errors were made on the imagery section of the test than on the verbal section of the test λ^2 (1, N = 2272) $= -.018$, $p < .001$), and in general more stimulus items incurred errors on the imagery section compared to the verbal section.

Table 5.7

The number of errors on the VICS in each section (verbal, imagery), each stimulus type (natural, man-made, mixed, smaller, bigger, equal) and at each session and the percentage of participants who made those errors. The number of items that caused errors for each test, stimulus type and session and the percentage of items that caused an error is also given.

Test	Stimuli Type	Session 1	N	%	Session 2	N	%	Total	N	%
Verbal	Natural	No of Errors	17	0.6%	No of Errors	20	0.8%	No of Errors	37	0.7%
		No of Items	9	17%	No of Items	15	28%	No of Items	21	20%
	Man-made	No of Errors	54	2.1%	No of Errors	49	1.9%	No of Errors	103	2.0%
		No of Items	20	38%	No of Items	17	32%	No of Items	26	25%
	Mixed	No of Errors	50	8.6%	No of Errors	57	9.8%	No of Errors	107	9.2%
		No of Items	12	100%	No of Items	12	100%	No of Items	12	100%
Total	Total Verbal	No of Errors	121	2.2%	No of Errors	126	2.2%	No of Errors	247	2.2%
		No of Items	41	35%	No of Items	44	38%	No of Items	59	25%
Imagery	Bigger	No of Errors	64	2.6%	No of Errors	56	2.2%	No of Errors	120	2.4%
		No of Items	33	63%	No of Items	31	60 %	No of Items	43	41%
	Smaller	No of Errors	85	3.4%	No of Errors	81	3.2%	No of Errors	166	3.3%
		No of Items	35	67%	No of Items	37	63%	No of Items	47	45%
	Equal	No of Errors	25	4.3%	No of Errors	28	4.8%	No of Errors	53	4.6%
		No of Items	10	83%	No of Items	9	75%	No of Items	12	100%
Total	Total Imagery	No of Errors	174	3.0%	No of Errors	165	3.0%	No of Errors	339	3.0%
		No of Items	78	67%	No of Items	77	66%	No of Items	102	44%

Within the verbal section of the test, more of the subjects' errors were made on the mixed stimuli followed by the man-made stimuli and the natural stimuli λ^2 (2, N = 11136) = 316.2, p <.001) (see Table 5.7). Furthermore, all the mixed items incurred errors, and more man-made than natural items incurred errors. Another way of interpreting these results is that given the question "Are X and Y natural?" more errors were made when the correct answer was "Mixed" or "No" than when the answer was "Yes". This pattern of errors is also reflected in the reaction times with the mixed items and man-made items incurring longer reaction times than natural items (see Table 5.4).

Within the imagery section of the test, more errors were made on the same items, followed by the smaller items and the bigger size items λ^2 (2, N = 11136) = 17.7, p<.001) (see Table 5.7). Furthermore, all of the equal sized items incurred errors and a higher number of smaller items than bigger items resulted in errors. Another interpretation of these results is that when asked the question "Is X bigger than Y?" more errors were made on the answers "Equal" and "No" than when the answer was "Yes". This pattern is also reflected in the reaction times with faster reaction times occurring when the answer was "Yes" and slower response times when the answer was "No"(see Table 5.4).

Items that had an error rate of higher than 10% are listed in Table 5.8 and Table 5.9 along with the number of times the error was made. Ten items on the verbal section of the test and 10 items on the imagery section of the test were found to result in an error rate of greater than 10%.

In the verbal section of the test, no natural items resulted in an error rate of greater than 10% (see Table 5.8). Most of the high error rates in the verbal section were on the mixed items, where the word form of the mixed items were generally more difficult than the picture form, but this difference was not significant. Note also that several of the items that caused difficulty in the word form also caused difficulty in the picture form, indicating that the content of the item probably caused the difficulty. The item in the verbal section that caused the most errors was "Are Bread and Whistle natural?" to which the correct answer was argued to be "No" they are both man-made. Most subjects made the mistake of thinking that bread was natural probably because it is seen as a staple part of most people's diets.

Table 5.8

Table showing the picture and word verbal stimuli in the VICS test that caused more than 10 % of the total errors at each session. Subjects were required to answer the question "Are these both natural?"

Verbal(Are these Natural?)	Form	Stimuli	Session 1	Session 2	Total
Answer = No	Pictures	Ashtray and Snowman	N = 7	N = 6	N = 13
	(Man-made)	Bread and Whistle *	N = 10	N = 9	N = 19
	Word	Bread and Whistle *	N = 17	N = 17	N = 34
	Total man-made		N = 34	N = 32	N = 66
Answer = Mixed	Pictures	Nose and Ladder *	N = 2	N = 7	N = 9
	(Mixed)	Tiger and Balloon *	N = 4	N = 6	N = 10
		Cat and Hammer	N = 8	N = 1	N = 9
	Words	Nose and Ladder *	N = 7	N = 7	N = 14
		Tiger and Balloon *	N = 6	N = 5	N = 11
		Screw and Frog	N = 4	N = 7	N = 11
		Pineapple and Guitar	N = 5	N = 8	N = 13
	Total mixed		N = 36	N = 41	N = 77
Total of Man-made + Mixed			N = 70	N = 72	N = 142

* Items that have error rates of greater than 10 % in both pictures and word form

In the imagery section of the test most items with error rates of greater than 10% were the smaller items, followed by the equal sized items and then the bigger items (see Table 5.9). As in the verbal section of the test several of the items that caused an error in the word form also resulted in a high error rate in the picture form. Again this indicates that it was probably the content of the stimuli not the item that was problematic. The items that caused the most errors were "Is Shoe bigger than Toaster?" to which the correct answer was argued to be "No" and "Is Pear bigger than an Ear?" to which the correct answer was argued to be "Yes". Most subjects made the mistake of thinking shoe was bigger than a toaster and that pear and ear are the same size.

Finally, significant differences in the subjects' overall reaction times between test items answered correctly or incorrectly were found for the verbal section of the VICS (t [11134] = 3.408, p <.001) and for the imagery section of the VICS (t [11134] = 4.531, p < .001). In both cases, the items that were answered incorrectly corresponded to slower reaction times.

In summary, the analysis of the errors on the VICS show that, overall, subjects made few errors (on average less than 3.1 % of all responses were errors). No differences were found in the number of errors made at each session and there was no difference in the number of errors made between the first and second exposures. Slightly more errors were found on the imagery test than on the verbal test and answers that required a "Yes" resulted in fewer errors. Future versions of the VICS could consider revising some of the items that attracted more than 10% of the errors.

5.3.3 How similar were the verbal and imagery reaction times overall?

For the purposes of discovering cognitive style differences, individual differences in reaction times are more important than means. To discover whether participants were responding at similar relative speeds on the verbal and imagery sections of the VICS over time, each participant's median reaction time on the verbal and imagery sections at session 1 was correlated with each participant's median reaction on the verbal and imagery section at session 2 (see Table 5.10). Similarly, in order to discover whether performance on the pictures and words was similar over time, each participant's median reaction time on the pictures and words at session 1 was correlated with their median reaction times on the pictures and words at session 2

Table 5.9

Table of the picture and word imagery stimuli in the VICS test that caused more than 10 % of the total errors at each session. Subjects were required to answer the question "Is stimulus X on the left bigger than stimulus Y on the right?"

Imagery Test (Is X bigger than Y?)		Stimuli	Session 1	Session 2	Total
Yes (1st item is bigger)	Pictures	Kite and Glove	N = 5	N = 0	N = 5
	Words	Tree and Penguin	N = 3	N = 5	N = 8
	Total bigger		N = 8	N = 5	N = 13
No (1st item is smaller)	Pictures	Shoe and Toaster *	N = 7	N = 6	N = 13
		Ear and Pear *	N = 6	N = 6	N = 12
	Words	Shoe and Toaster *	N = 13	N = 9	N = 22
		Ear and Pear *	N = 8	N = 10	N = 18
		Pear and Monkey	N = 5	N = 1	N = 6
	Total smaller		N = 37	N = 32	N = 71
Equal (Items are equal)	Pictures	Rabbit and Duck *	N = 4	N = 7	N = 11
	Words	Rabbit and Duck *	N = 4	N = 7	N = 11
		Pen and Fork	N = 5	N = 3	N = 8
	Total Equal		N = 13	N = 17	N = 30
Total of Bigger + Smaller + Equal			N = 58	N = 54	N = 114

* Items that have error rates of greater than 10 % in both pictures and word

(see Table 5.11). Finally, in order to find out if performance at stimulus exposure 1 was similar to stimulus exposure 2, each subject's median reaction time at exposure 1 was correlated with their median reaction time at exposure 2 (see Table 5.12).

In each case, the correlations between the test sections, stimulus forms and stimulus exposures were high, ranging from $\underline{r} = .71$ to $\underline{r} = .94$. Of particular interest were the high test-retest (session 1 versus session 2) correlations for the verbal ($\underline{r} = .86$) and the imagery ($\underline{r} = .89$) sections of the test. These findings show extremely reliable individual differences in reaction times on the verbal section and on the imagery sections at both sessions 1 and 2. Similarly, the correlations within each stimulus form (i.e., pictures at session 1 and 2, or words at sessions 1 and 2) were also very high (verbal word $\underline{r} = .85$, verbal picture $\underline{r} = .84$, imagery word $\underline{r} = .85$, imagery picture $\underline{r} = .87$). Furthermore, the correlations between test exposures at the same session (i.e., stimuli presented at the first exposure in session 1 and session 2, or stimuli presented at the second exposure at session 1 and 2) were also high (all correlations were above $r = .83$), but not as high as stimuli presented at the same session within the verbal and imagery sections. In other words, performance on items that subjects had not seen before was similar to performance on items that that they had seen before in a different form and responses are most similar within each test section (verbal, imagery) and session. Together, these findings indicate massively reliable individual differences in reaction times across session, stimulus type and stimulus exposure.

In summary, the results presented above indicate that subjects' median reaction times on each section of the task (verbal and imagery), on both stimulus forms (pictures and words) and at each exposure (exposure 1 and exposure 2) show highly consistent individual differences. Our attention can now be turned to whether participants show speed based preferences in the processing of different task sections (i.e., a verbal or imagery task preference) and different stimulus forms (i.e., a picture or word format preference). In other words, this section moves us closer to identifying whether the VICS can detect whether subjects have a stable verbal-imagery or picture-word cognitive style preference.

5.3.4 Assessment of verbal imagery cognitive style preference.

To examine whether participants have a verbal or imagery style preference, a measure is required which directly compares each participant's performance on the verbal items to their performance on the imagery items. In other words, the reliability of the reaction time means given above tells us nothing about cognitive style preferences for verbal or imagery processing.

Table 5.10

Pearson's correlations coefficients between the median reaction time in ms for the VICS test for each section (verbal, imagery) and session (1, 2). Correlations in bold show the correlations within the same test section (verbal, imagery). All results were significant at $p < .001$.

	1	2	3
1. VICS, Verbal, S1			
2. VICS, Verbal, S2	**.867**		
3. VICS, Imagery, S1	.854	.829	
4. VICS, Imagery, S2	.808	.856	**.890**

Table 5.11

Pearson's correlations coefficients between the median reaction time in ms for the VICS test for each test section (verbal, imagery), stimulus form (words, pictures) and session (1 and 2). Items in bold show the consistency of reaction times within each test section. Items underlined show the correlations within the same stimulus form (pictures, words). N = 48. All results were significant at the $p < .001$ level.

	1	2	3	4	5	6	7
1. VICS, Verbal, Word, S1							
2. VICS, Verbal, Word, S2	**.848**						
3. VICS, Verbal, Pict, S1	**.936**	**.800**					
4. VICS, Verbal, Pict, S2	**.871**	**.931**	**.841**				
5. VICS Imagery, Word, S1	.820	.831	.824	.804			
6. VICS Imagery, Word, S2	.742	.866	.750	.828	**.845**		
7. VICS Imagery, Pict, S1	.801	.788	.862	.773	**.944**	**.844**	
8. VICS Imagery, Pict, S2	.802	.800	.829	.834	**.840**	**.893**	**.873**

Table 5.12

Pearson's Correlation Coefficients between the median reaction time in ms for the VICS test for each test section (verbal, imagery) each test exposure (first half, second half) and session (1, 2). Items in bold show the consistency of reaction times within each test section. Items underlined show the correlations within the same test exposure. N = 48. All results were significant at the $p < .001$ level.

	1	2	3	4	5	6	7
1. VICS, Verbal, 1st half, S1							
2. VICS, Verbal, 2nd half S1	**.913**						
3. VICS, Verbal, 1st half, S2	**<u>.844</u>**	**.904**					
4. VICS, Verbal, 2nd half, S2	**.718**	**<u>.839</u>**	**.895**				
5. VICS, Image, 1st half, S1	.800	.849	.836	.785			
6. VICS, Image, 2nd half, S1	.766	.826	.805	.743	**.896**	.	
7. VICS, Image, 1st half, S2	.768	.834	.837	.843	**<u>.845</u>**	**.868**	
8. VICS, Image, 2nd half, S2	.719	.801	.807	.851	**.853**	**<u>.884</u>**	**.930**

To examine verbal-imagery preferences, Riding's (1991, 1998) CSA takes a ratio of each participant's average verbal reaction time to each participant's average imagery reaction time. Hence, each participant ends up with a score that places him or her somewhere along a verbal-imagery continuum. Like the CSA, the VICS is also designed to investigate whether participants have a verbal or an imagery preference. However, the VICS can investigate whether participants have a verbal or imagery preference by creating ratios in a variety of ways. The possible ways of calculating the verbal-imagery preference ratio are outlined below.

1. A ratio between each participant's average reaction time (RT) on the verbal test section can be made with each participant's average RT on the imagery test section.
2. A ratio between each participant's average RT on picture items can be compared to their average RT on word items.
3. The picture to word RT ratio can be examined in the verbal task alone.
4. The picture to word RT ratio can be examined in the imagery task alone.
5. A ratio looking at the extremes of each task section and each stimulus form can be taken. That is, a ratio of each participant's performance on the verbal task's word stimuli can be taken with each participant's performance on the imagery task picture stimuli
6. In case the second exposure to the contents of a stimulus adversely affects a participant's performance, a ratio of the average RT on the verbal test section to the average RT on the imagery test section can be calculated using only the items the participants have seen for the first time (i.e. only at the first exposure) or the second time (i.e. only at the second exposure).
7. Finally, a ratio of average performance on pictures and words can be calculated for the first exposure alone and the second exposure alone.

These seven ways of creating ratios to examine verbal or imagery preferences on the VICS were calculated. The stability of these ratios over time (at session 1 and session 2) is shown below (see Table 5.13).

5.3.5 The reliability of verbal-imagery ratios: is there a stable style preference?

Table 5.13 shows that the ratio which compared overall performance on the verbal section with overall performance on the imagery section was the most stable between session 1 and session 2 ($\underline{r}_s$ = .61) and it was also found to have a bivariate normal distribution (see Figures 5.5 and 5.6).

Table 5.13

Pearson's and Spearman's Correlation Coefficients for the VICS ratios at session 1 and session 2.

Variable of Interest	Ratio	Pearson's r	Spearman's rho
Task (Verbal vs Imagery)	VICS Verbal / Imagery task Ratio S1 vs S2	.50 (.000)	.61 (.000)
Form (Picture vs Words)	VICS Picture / Word Ratio, S1 vs S2	.43 (.002)	.43 (.002)
Verbal Task (Pictures vs Words)	VICS Picture / Word Ratio in Verbal task, S1 vs S2	.32 (.028)	.32 (.027)
Imagery Task (Pictures vs Words)	VICS Picture / Word Ratio in Imagery task, S1 vs S2	.31 (.035)	.17 (.258)
Pictures Only (Verbal vs Imagery)	VICS Verbal / Imagery task Ratio in Pictures only S1 vs S2	.41 (.004)	.47 (.001)
Words Only (Verbal vs Imagery)	VICS Verbal / Imagery task Ratio is Words only, S1 vs S2	.47 (.001)	.50 (.000)
Imagery-Pictures vs Verbal-Words	VICS Imagery Pict / Verbal Word Ratio, S1 vs S2	.50 (.000)	.54 (.000)
1st half (Pictures vs Words)	VICS Pictures / Words Ratio, S1 vs S2	.13 (.384)	.19 (.199)
1st half (Verbal vs Imagery)	VICS Verbal / Imagery Ratio, S1 vs S2	.26 (.072)	.27 (.060)
2nd half (Picture vs Words)	VICS Pictures / Words Ratio, S1 vs S2	.43 (.002)	.43 (.002)
2nd half (Verbal vs Imagery)	VICS Verbal / Imagery task Ratio, S2 vs S2	.61 (.000)	.58 (.000)

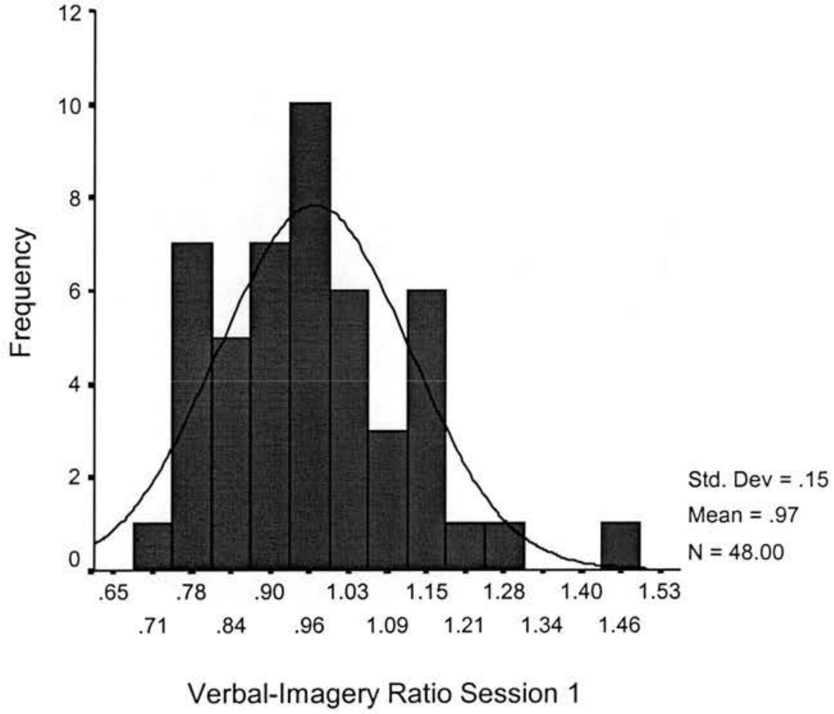

Figure 5.5
Histogram of verbal/imagery ratio on the VICS at Session 1

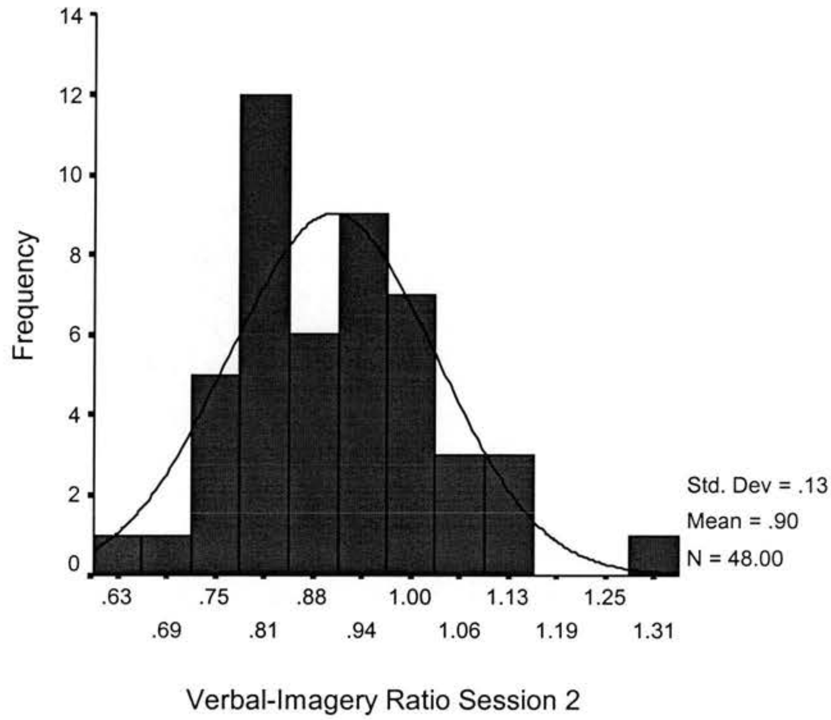

Figure 5.6
Histogram of the verbal-imagery ratio on the VICS at session 2

The parametric correlation coefficient of this verbal-imagery ratio at session 1 and 2 was somewhat lower (r = .50).

The second most stable correlation between the ratios (at session 1 and session 2) was the correlation between the verbal and imagery section of the test for the second exposure (r = .61, r_s = .58) followed by the correlations between the verbal words / imagery picture extremes (r = .50, r_s = .54).

A scattergram of the verbal/imagery ratios at session 1 and session 2 was also inspected to further examine the spread of the data. One participant was an outlier (see Figure 5.7). When this participant was asked whether she did anything different at session 2 that she did not do in session 1, she replied that in session 1 she read each stimulus in her head, translating all pictures into the word form, before answering. At session 2 she just looked at the pictures and words and judged them on face value. When this participant was removed and the data was re-analysed most of the correlations between the ratios increased slightly (see Table 5.14). Of particular interest are the correlations between the verbal-imagery task ratios at session 1 and session 2 (r = .62, r_s = .66) and the correlations between the extremes (imagery pictures/ verbal words) at session 1 and session 2 which also increased (r = .60, r_s = .56).

The analysis above indicated that the verbal-imagery ratio from the VICS was reliable at retest. To examine whether the VICS was internally consistent, responses on even and odd items from both the verbal and imagery sections of the test were split creating two halves (odd, even) for each test section (verbal, imagery). The split data was then re-analysed. The subjects' median reaction times from each half of the split data were not significantly different. Given that the most reliable style ratio over time was the one between the verbal task to imagery, this ratio was also calculated using the split-half data to check for internal consistency. The correlations between the split-half verbal-imagery task ratios were high at both session 1 (r = .72) and session 2 (r = .78).

In summary, the analysis of the verbal-imagery VICS ratios indicated that the most reliable and internally consistent way of measuring whether participants have a verbal or imagery preference on the VICS is by comparing participants' speed of response on the verbal section of the test with their speed of response on the imagery section of the test (note that each of these sections contain an equal number of word and picture-based items). This ratio was found to have high internal

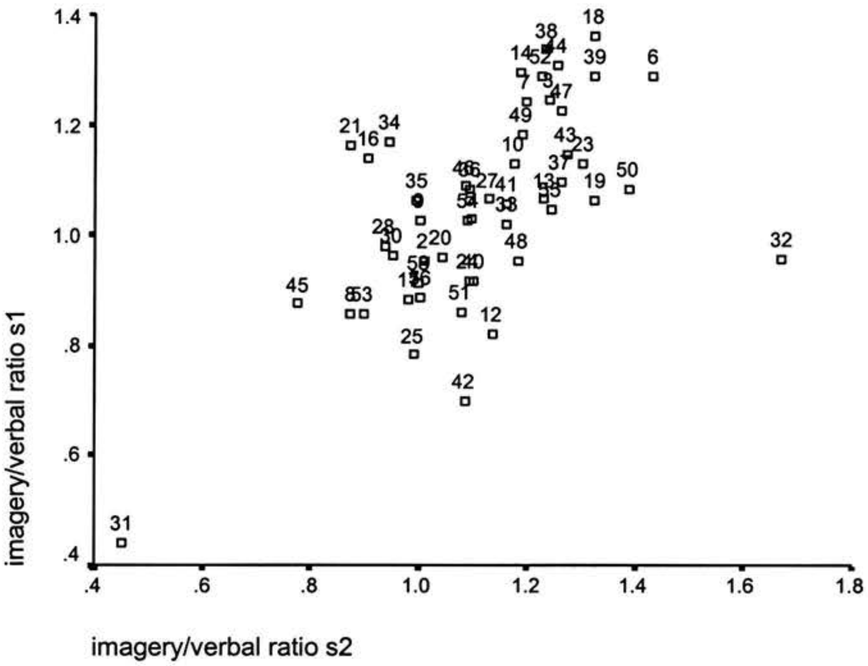

Figure 5.7
Showing the verbal-imagery reaction time ratio at S1 vs S2 with subject 32 identified as an outlier.

Table 5.14

Pearson's and Spearman's correlations for the VICS ratios without subject 32.

Variable of Interest	Ratio	Pearson's r	Spearman's rho
Task (Verbal vs Imagery)	VICS Verbal / Imagery task Ratio, S1 vs S2	.56 (.000)	.66 (.000)
Form (Pictures vs Words)	VICS Picture / Word Ratio, S1 vs S2	.26 (.077)	.25 (.090)
Verbal Task (Pictures vs Words)	VICS Picture / Word Ratio in Imag task, S1vs S2	.30 (.038)	.30 (.043)
Imagery Task (Pictures vs Words)	VICS Picture / Word Ratio in Verb task, S1 vs S2	.23 (.115)	.11 (.451)
Pictures Only (Imagery vs Verbal)	VICS Imagery / Verbal task Ratio in Pictures only, S1 vs S2	.50 (.000)	.51 (.000)
Words Only (Imagery vs Verbal)	VICS Imagery / Verbal task Ratio In Words only, S1 vs S2	.57 (.000)	.59 (.000)
Imagery-Pictures vs Verbal-Words	VICS Imagery Pictures / Verbal Word ratio, S1 vs S2	.60 (.000)	.56 (.000)
1st half (Pictures vs Words)	VICS Pictures / Words ratio, S1 vs S2	.11 (.446)	.16 (.296)
1st half (Imagery vs Verbal)	VICS Imagery / Verbal task ratio, S1 vs S2	.31 (.034)	.33 (.022)
2nd half (Pictures vs Words)	VICS Pictures / Words ratio, S1 vs S2	.34 (.020)	.39 (.007)
2nd half (Imagery vs Verbal)	VICS Imagery / Verbal task ratio, S1 vs S2	.62 (.000)	.63 (.000)

consistency and good stability between session 1 and session 2, especially when one participant (an outlier) was removed.

5.3.6 Summary of the VICS results

Overall, there are four main findings from the VICS. Firstly, the VICS appears to involve a relatively low error rate. Secondly, performance at session 2 and exposure 2 was faster than session 1 and exposure 1. Thirdly, pictures were responded to more quickly than words. Finally, by far the most important finding was that individual differences in the VICS verbal-imagery reaction time ratios had a split half reliability of more than .7 and a test-retest reliability greater than .6. These coefficients are high, especially for ratio measures.

5.3.7 Results of the CSA-VI-A and the CSA-VI-B

The accuracy and reaction times were recorded for 50 participants on each test version (CSA-VI-A, CSA-VI-B), each test section (verbal, imagery), and at each session (session 1, session 2). Two participants were excluded as they failed to meet Riding's (1998) criteria of less than a 30% error rate. Note these two participants were the same participants that were excluded from the VICS test analysis.

The mean, median and standard deviation of the reactions for each test version, section and session are reported in Table 5.15 and the anova results for the CSA-VI-A and the CSA-VI-B are presented below. However, as in the VICS, it is the individual differences in reaction times, especially individual differences in the verbal-imagery ratios, which are important for identifying cognitive style, not the overall means on each section of the test.

The analysis of variance found a main effect for session indicating that participants responded faster at session 2 than at session 1 ($\underline{F}$ [1, 47] = 103.2, $\underline{p} < .001$, $\eta^2 = .687$) and a main effect was found for test version indicating that participants responded faster on the CSA-VI-B which was administered after the CSA-VI-A ($\underline{F}$ [1,47] = 62.3, $\underline{p} < .001$, $\eta^2 = .570$). A small interaction was also found between the test section (verbal or imagery) and session (1 and 2) ($\underline{F}$ [1,47] = 5.016, $\underline{p} = .030$, $\eta^2 = .047$). This interaction appears to be due to more varied reaction times on the imagery dimension than on the verbal dimension.

Table 5.15

The means (M), medians (MD) and standard deviations (SD) of reaction times (ms) for the CSA-A, CSA-B on each section (verbal, imagery) and for each session (1, 2). (N = 48)

Test	Session	Verbal	Imagery
CSA-A	1	M = 2405 MD = 2106 SD = 1309	M = 2524 MD = 2195 SD = 1562
	2	M = 2194 MD = 1833 SD = 1380	M = 2033 MD = 1725 SD = 1239
CSA-B	1	M = 2256 MD = 1910 SD = 1327	M = 2252 MD = 1946 SD = 1264
	2	M = 1902 MD = 1557 SD = 1166	M = 1907 MD = 1589 SD = 1228

5.3.8 CSA-VI-A, CSA-VI-B: errors

The mean number of errors for each test version, section and session are reported in Table 5.16 below. Overall the average number of errors made by each participant was low (3.7 % on the CSA-VI-A and 3.0% on the CSA-VI-B). The CSA-VI-B was found to have significantly fewer errors than the CSA-VI-A(ϕ^2 (1, N = 9600) = .038, $p < .001$) but no difference in error rates were found between session 1 and session 2.

Items that had an error rate of higher than 10% are listed in Table 5.17 along with the number of times the error was made. Table 5.17 shows that 5 of the items with error rates of more than 10% were from the CSA-A, and 3 of them were from the CSA-B. It is interesting to note that three of the items ("Are Beans and Chicken the same type?", "Are Rice and Cheese the same type?" and "Are Bread and Butter the same colour?" were also found to incur high error rates in the reliability study in Chapter 3.

5.3.9 How similar are the CSA-VI-A and CSA-VI-B style ratios overall?

In keeping with the findings of Chapter 3, the correlations between the CSA-VI-A verbal and imagery median reaction times and the CSA-VI-B verbal and imagery median reaction times at session 1 and 2 were high, ranging from $r = .69$ to $r = .92$ $p< .001$ (see Table 5.18). The test-retest correlations for the CSA-VI-A and the CSA-VI-B were especially high, ranging from $r = .77$ to $r = .91$, $p < .001$. These findings suggest that participants show highly consistent relative reaction times on the verbal and imagery sections within the same test (the CSA-VI-A and CSA-VI-B) at session 1 and session 2.

5.3.10 CSA-VI-A and the CSA-VI-B ratios: are they stable?

To determine whether participants had a preference for responding to verbal or imagery stimuli, Riding (1998) calculates a ratio of the average response times of the verbal items to the imagery items. This gives each participant a score, which places him or her along a verbal-imagery style preference continuum.

The stability of individual differences in the correlations were calculated between the session 1 verbal-imagery ratios and the session 2 verbal-imagery ratios, for the CSA-VI-A and the CSA-

Table 5.16

Total number of errors, and the percentage of subjects that made the errors and the number of items that caused an error and the percentage of items that resulted in an error for each version of the test (CSA-A, CSA-B) section of the test (verbal, imagery) and each session (1, 2).

Test	Session	Verbal	%	Imagery	%	Total	%
CSA-A	S1 Errors	N = 50	4 %	N = 34	3 %	N = 84	3.6%
	No of Items	N = 15	63%	N = 14	58%	N = 29	60.4%
	S2 Errors	N = 40	3 %	N = 49	4 %	N = 89	3.8%
	No of Items	N = 14	58%	N = 15	63%	N = 29	60.4%
	Total No. Errors	N = 90	4%	N = 83	4 %	N = 173	3.7%
	Total No. Items	N = 29	60%	N = 29	60 %	N = 58	60.4%
CSA-B	S1 Errors	N = 38	3 %	N = 35	3 %	N = 73	3.0%
	No of Items	N = 12	50%	N = 13	54%	N = 25	52.1%
	S2 Errors	N = 35	3 %	N = 28	2 %	N = 63	2.7%
	No of Items	N = 11	45%	N = 13	54%	N = 24	50%
	Total No. Errors	N = 73	3%	N = 63	3 %	N = 136	3.0%
	Total No. Items	N = 25	52%	N = 24	50%	N = 49	51.1%

Table 5.17
Items on the CSA-A and the CSA-B that caused more than 10% of the errors on each test section and at each session

CSA-A Verbal	No or Errors at Session 1	No of Errors at Session 2	Total No of Errors
Beans and Chicken are the same Type (Y)	9	5	14
Fork and Spade are the same Type (N)	7	6	13
Rice and Cheese are the same Type (Y)	6	6	12
CSA-B Verbal			
Crossroad and Puzzle are the same Type (N)	9	4	13
CSA-A Imagery			
Bread and Butter are the same Colour (N)	9	19	
Elephant and Ivory are the same Colour (N)	2	7	28
			9
CSA-B Imagery			
Pumpkin and Broccoli are the same Colour (N)	7	5	12
Window and Water are the same Colour (N)	7	5	12

Table 5.18.

Table of the correlations coefficients between the median reaction times in ms for the CSA-A and CSA-B at each section (verbal, imagery) and session (1, 2). Correlations in bold show the consistency in reaction time within each test section. The underlined correlations show the test-retest correlations within the same test. All correlations were significant at $p < .001$.

	1	2	3	4	5	6	7
1. CSA-A, Verbal, S1							
2. CSA-A, Verbal, S2	**.772**						
3. CSA-B, Verbal, S1	**.802**	**.880**					
4. CSA-B, Verbal, S2	**.726**	**.907**	**.864**				
5. CSA-A, Imagery, S1	.871	.836	.884	.862			
6. CSA-A, Imagery, S2	.778	.912	.867	.917	**.914**		
7. CSA-B, Imagery, S1	.823	.801	.865	.823	**.852**	**.839**	
8. CSA-B, Imagery, S2	.694	.873	.851	.930	**.861**	**.922**	**.831**

VI-B, to see how reliable the style ratios were over time and how reliable the ratios were between the original and parallel version of the CSA test. The correlations between the ratios were low (range $r = .06$ to $r = .32$) and most of the correlations were non-significant (see Table 5.19 and Appendix 3 for the Spearman's correlations). In general, the small and largely non-significant correlations were in the direction expected, with the exception of one negative correlation between the verbal-imagery CSA-VI-A ratio at session 1 and the verbal-imagery CSA-VI-B ratio at session 1. The test-retest correlation for the CSA-VI-A ratio was the highest ($r = .30$); however, the test-retest correlation for the CSA-VI-B was low ($r = .06$).

Chapter 3 (see also Peterson et al., in press) found that an extended version of the CSA was more reliable than the CSA alone, especially for the wholistic-analytic dimension of the CSA which approached a split half reliability of $r = .69$. In contrast, the verbal-imagery dimension of the CSA did not benefit greatly from being extended ($r = .36$). To confirm this finding, each participant's data from the CSA-VI-A was combined with his or her data from the CSA-VI-B and re-analysed, creating a combined CSA (C-CSA) data set. Correlations between the combined raw scores are high (see Table 5.20). Analysis of the C-CSA ratios showed that the C-CSA verbal-imagery ratio at session 1 correlated poorly with the C-CSA verbal-imagery ratio at session 2 ($r = .17$, $p = .241$) (see Table 5.21), it was not stronger than the CSA-VI-A or the CSA-VI-B ratio alone (compare with Table 5.19) and it was considerably lower than the correlations between the VICS session 1 and 2 ratios (see Table 5.21). These findings were in keeping with the findings of Chapter 3 in that they suggests that the C-CSA is no more reliable than the CSA-VI-A or the CSA-VI-B at detecting style preferences.

In keeping with the VICS, data from the C-CSA was split to check for internal consistency; the CSA-A was not used as it contained insufficient items for a split half analysis. The verbal-imagery ratios from the split C-CSA data were then correlated and found to be close to zero at both session 1 ($r = .025$) and session 2 ($r = -.107$).

5.3.11 Summary of the CSA-VI-A, CSA-VI-B and C-CSA results

In summary, the CSA-VI-A, CSA-VI-B results have revealed three main findings. Firstly, participants performed quicker at session 2 than at session 1 and quicker on the test that was administered second (CSA-VI-B). Secondly, the error rate on the CSA-VI-A (which was administered first) was significantly larger than the error rate on the CSA-VI-B (which was administered second). Thirdly, the initial correlations between the median reaction times at session 1 and 2 were high, indicating that overall individual differences in responding on the

Table 5.19

Pearson's correlation coefficients between the style ratios for the CSA-A and the CSA-B for each section of the test (verbal, imagery) and for each session (S1, S2), p values are given in brackets. Items in bold show the correlations within the same test.

	1	2	3
CSA-A, Verbal-imagery Dimension, S1			
CSA-A, Verbal-imagery Dimension, S2	**.302** (.037)		
CSA-B, Verbal-imagery Dimension, S1	-.230 (.116)	.150 (.309)	
CSA-B, Verbal-imagery Dimension, S2	.134 (.362)	.218 (.136)	**.056** (.703)

Table 5.20

Table of the Pearson's correlations coefficients between the median reaction times in ms for the Combined CSA-A and the CSA-B test at each section (verbal, imagery) and session (1, 2). Correlations in bold show the test-retest correlations within the same test. All correlations were significant at $p < .001$

	1	2	3
1. C-CSA Verbal, S1			
2. C-CSA, Verbal, S2	**.864**		
3. C-CSA, Imagery, S1	.929	.901	
4. C-CSA, Imagery, S2	.866	.906	**.918**

Table 5.21

Pearson's correlations coefficients for the C-CSA and the VICS ratios at session 1 and session 2. Items in bold show the correlations within each test.

	1	2	3
1. C-CSA Verbal Imagery ratio S1			
2. C-CSA Verbal Imagery ratio S2	**.174** (.241)		
3. VICS Verbal-Imagery ratio S1	-.161 (.280)	-.009 (.951)	
4. VICS Verbal-Imagery ratio S2	-1.45 (.333)	-.015 (.922)	**.619** (.000)

two tests was consistent. Finally, the most important finding was that the internal consistency on the C-CSA verbal-imagery ratios were less than r = .11 and the verbal and imagery ratios on the CSA-VI-A, CSA-VI-B and on the combined C-CSA test were not stable over time (less than r = .31). These correlations are well below the acceptable level for a psychometric test.

Comparison between the CSA-VI-A, CSA-VI-B, and the VICS

Comparison between participant error rates on the CSA-VI-A and the CSA-VI-B with participant error rates on the VICS show that, on average, participants made a similar number of errors on each test. However, in proportion to the size of the test, there were fewer items that resulted in errors on the VICS.

The correlations between the median reaction times at session 1 and session 2 were high for all versions of the CSA and for the VICS (Mean r = .87, Range r = .77 -. 92). Furthermore, most of the responding fell within the narrow response range of 1000 – 2000 ms typical of reaction time data.

The biggest difference between the tests was in the reliability and the internal consistency of the style ratios. The results indicated that the VICS ratios showed good reliability and internal consistency whereas the CSA style ratios did not.

In summary, the basic correctness of responses and speeds of responses are acceptable in both tasks. It is crucially when one calculates a ratio between the types of items that the difference between the CSA and VICS appears.

5.3.12 Did the CSA test ratios correlate with the VICS ratios?

In order to examine whether the VICS verbal-imagery ratio and the CSA verbal-imagery ratios shared variance, this study investigated the degree to which the crucial CSA-VI-A verbal-imagery ratio, CSA-VI-B verbal-imagery ratio and C-CSA verbal-imagery ratio correlated with the crucial VICS verbal-imagery ratio. Overall the correlations between the test ratios were low and ranged from r = -. 27, p = .06 to r = .17, p = .24, suggesting that the two ratios from the CSA and the VICS are not measuring the same thing. However, these correlations are expected in view of the low reliability of the CSA ratios.

5.3.13 Summary of main findings

The major novel findings of this experiment were that the internal consistency of the crucial verbal-imagery ratios on the VICS were high ($r > .70$) and the verbal imagery ratios at re-test on the VICS were also stable ($r > .55$). In contrast, the internal consistency of the verbal-imagery ratios on the C-CSA were low ($r < .11$) and the verbal-imagery ratios at re-test on the original CSA (CSA-VI-A) and on a parallel version (CSA-VI-B), although better (both less than $r =$ .31), were still below acceptable levels for a psychometric test. This study also confirmed the findings of Chapter 3 that even extending the length of the CSA's verbal-imagery dimension does not improve its reliability. Finally, this study showed that the crucial CSA verbal-imagery ratios did not correlate with the crucial VICS verbal-imagery ratios.

5.4 Discussion

This study reports the construction of a new test of individual differences in verbal-imagery style preferences. The most important contributions of this study were the development of the new VICS and demonstration that it is a more reliable and internally consistent measure of individual differences in verbal-imagery cognitive style than the verbal-imagery dimension of the popular CSA test. These claims are supported by the fact that the crucial verbal-imagery cognitive style ratio, which is used to determine individual differences in verbal-imagery cognitive style, was internally consistent ($r > .7$) and stable at re-test ($r = .56$) on the new VICS, whereas the verbal-imagery ratios of the C-CSA lacked internal consistency ($r < .11$) and the CSA-VI-A, CSA-VI-B and C-CSA were not stable at re-test ($r < .31$). Furthermore, the low reliability of the CSA-A, CSA-B and C-CSA ratios was in keeping with the findings of Chapter 3 and Peterson et al. (in press) and Redmond et al. (2002).

The results of this study suggest that the VICS' verbal-imagery ratio was more internally consistent and stable than the CSA's verbal-imagery ratios in part because the VICS had a more appropriate and less ambiguous test design. The design advantages of the VICS over the CSA are three-fold. Firstly, the VICS controls for differences in word frequency, image agreement and name agreement for all stimuli used in both the verbal and imagery task. This means that any individual differences in participant performance on the verbal and imagery sections could not be accounted for by these factors. Secondly, the questions in both the verbal and imagery sections of the VICS tasks were designed to be less ambiguous than the questions used on the CSA. The smaller percentage of VICS errors (an average of 2.6% of errors per subject) compared to the percentage of errors on the CSA-A (an average of 7.5% of errors per subject) and CSA-B (an average of 5.9 % of errors per subject) supports this. Finally, the VICS had almost five times as many stimuli as the original CSA, giving a greater number of items to test each style dimension.

This study initially proposed that individual differences in the speed of processing pictures and words might also reflect individual differences in verbal-imagery cognitive style. To test this, the VICS, unlike the CSA, included word and picture stimuli to assess the corresponding verbal and imagery style dimensions. However, the results showed, that individual differences in the speed of picture versus word processing were less stable at retest ($\underline{r} = .30$), than individual differences on the speed of overall verbal vs. imagery tasks processing ($\underline{r}. = .56$) (see Table 5.13 and 5.14).

Another important finding was that the verbal-imagery ratios on the VICS did not correlate significantly with the verbal-imagery ratios from the CSA tests. This is not surprising given that it is difficult to get a significant correlation between two measures when one of them, in this case the CSA, does not even correlate with itself. Nevertheless, one interpretation of the low correlations between the two tests could be that the VICS and the CSA test are not measuring the same thing. An alternative, and arguably more likely explanation, is that one test (the VICS) was more successful than the other (the CSA) at measuring verbal-imagery cognitive style preference, but proving this theory is more difficult. Nevertheless, this thesis suggests that the low internal reliability of the CSA and the difference in the effectiveness with which the two tests measure cognitive style, probably made the correlations between the verbal-imagery ratios of the two tests low and non-significant.

The differences between the reliability of the VICS and the reliability of the CSA-A, CSA-B and C-CSA were all found to be significant at $\underline{p} < .02$. Although this experiment had a modest sample size (with a final $\underline{N} = 47$), the power of the test was high and therefore the stability of the VICS verbal-imagery ratios between session 1 and session 2 should be taken seriously.

As noted above, the key variables of interest in this study were the consistency of the individual differences in reaction times and specifically the reliability of the reaction time ratios. For this reason, the analysis of variance results, which examined differences in overall mean reaction times, were not considered important as this told us nothing about individual differences in style preferences. Nevertheless the anova results and examination of test errors produced some interesting findings.

Analysis of variance of the VICS results found main effects for session (1, 2), stimulus exposure (first, second), stimulus form (pictures, words) and task (verbal, imagery).

The main effects for session and stimulus exposure probably reflected a practice effect with performance at session 2 and on the second exposure to a stimulus being faster than at session 1 or on exposure 1. It is likely that this increase in the speed of response reflects task familiarity rather than subjects remembering the items because the number of errors between the sessions and between the exposures were not significantly different.

A main effect for stimulus form indicated that, overall, pictures were processed significantly faster than words. Previous research has shown that pictures tend to be recalled better than words (Paivio & Csapo, 1969; Shepard, 1967) and that words are automatically named faster than pictures (Paivio & Begg, 1974; Fraisse, 1968; Paivio, 1975). This experiment however, did not require recall or naming, the VICS task was essentially a categorisation task. Research findings on the speed of picture and word categorisation are less unified, with some researchers claiming that words are categorised faster than pictures (Smith & Magee, 1990) and others claiming that pictures are categorised faster than words (e.g., Potter & Faulconer, 1975). The finding of the current study adds support to the latter. Speculation on why this might be is beyond the scope of this study.

The main effect for task indicated that the verbal section of the task, resulted in slightly faster reaction times than the imagery section of the task despite the fact that the imagery section of the task was administered second. This may indicate that the verbal section of the VICS was slightly easier than the imagery section. A small interaction between task and session was also found which suggests that the verbal task incurred faster response times at session 2 but more similar response times to the imagery section at session 1.

Within each section of the task (verbal and imagery), there also appeared to be a response bias. That is, when the correct answer was "Yes" to the questions "Are X and Y natural?" and "Is X bigger than Y?", subjects' responses tended to be faster than when the correct response was "No", "Mixed" or "Equal". The faster response time to give affirmative responses is in keeping with previous research (e.g., Reading & Hemsley, 1975) and may reflect the cognitive demand of the question, with "Yes" responses being the simplest and "No", "Mixed" and "Equal" responses being slightly more cognitively demanding.

Looking more closely at the VICS, an analysis of the errors showed that less than 3.1 % of all responses resulted in errors. Therefore on average subjects were responding with 97 % accuracy, which suggests that the questions were not difficult and hence the test was probably not a test of ability.

More errors were made on the imagery section than on the verbal section of the VICS test (3% vs 2.2%) but no differences in error rates were found between session 1 and 2, exposure 1 and 2 and between pictures and words. The higher number of errors on the imagery task is also reflected in the slower reaction times. As mentioned above, the higher number of imagery errors and slower reaction times may be due to the imagery task being slightly harder than the verbal task.

Of the items that incurred more than 10% of the errors, six of them had high error rates in both the word form and the picture form, and eight items had high error rates in only one form. The most problematic items overall were "Are Bread and Whistle natural?", "Is Shoe bigger than Toaster?" and "Is Pear bigger than Ear?". The subjects who made an error on "Are Bread and Whistle natural?" frequently responded that these items were mixed. The confusion may have occurred because bread is generally considered a basic food source and hence it may have been regarded as similar to other natural products like fruit and vegetables. Errors made on "Is Shoe bigger than Toaster?" were mainly from subjects who responded "Yes" when the correct answer was "No". This seemed to occur largely with tall subjects who considered that their shoes were bigger than toasters. Finally, errors made on "Is Pear bigger than Ear?" were mainly from subjects who responded "equal" when the correct answer was "Yes". A revised versions of the VICS changed these items in attempt to reduce subject error rates (see Chapter 7).

The analysis of variance results from the CSA found main effects for test session (1, 2) and test version (CSA-A, CSA-B). These effects were probably due to a practice effect whereby performance at session 2 and on the test that was administered second (CSA-B), was faster than performance at session 1 and on the test administered first (CSA-A). A small interaction was also found between the test section (verbal, imagery) and session (1, 2).

Analysis of the CSA-A and the CSA-B errors showed less than 3.7 % of all responses were errors, which is similar to the findings of Chapter 3. Several of the items with high error rates in Chapter 3 also attracted high error rates in this study. More specifically, the items "Are Beans and Chicken the same type?", "Are Rice and Cheese the same type?"; "Are Bread and Butter the same colour?" and; "Are Crossroad and Puzzle the same type?" featured as error prone items. A further four additional items that were not found in Chapter 3 also had high error rates. The current study also found that the CSA-A attracted significantly more errors than the CSA-B, but this difference was probably due to the practice effect as the CSA-B was administered second.

5.4.1 General discussion

The overall importance of this study's findings can be seen when the results are viewed within the historical context of cognitive style research. Over the past 60 years, many different cognitive style labels have been proposed (Riding, 2001). Concern has frequently been raised as to the objectivity, reliability and validity of cognitive style measures (Messick, 1984; Tiedermann, 1989; Vernon 1963). This has led to claims that in cognitive styles research, there is "an enormous gap between the conceptual and empirical level" (Tiedermann, p.272).

Riding's verbal-imagery and wholistic-analytic dimensions and the CSA test designed to measure them, were initially heralded as an answer to this problem. Indeed, Presland (1994) refers to Riding's 'valiant attempt to give some structure to the body of knowledge in this area and to suggest ways forward' (p.179). Currently, the CSA is one of the two most popular measures of styles designed and used in the UK (Presland, 1994). Its success is largely because, compared to many other proposed style measures, the CSA test has been the object of a substantial amount of published work (including providing evidence of the CSA's validity), the test is easy to administer, it is available in seven languages, and the CSA's dimensions (wholistic-analytic and verbal-imagery) appear to have grown out of existing style theories.

This thesis however, has shown in a sample of 48 that the wholistic-analytic and verbal-imagery dimensions of the CSA are not reliable measures (Chapter 3)[2]. More specifically, Chapters 3 showed that in a sample of 50 participants the test-retest reliability, parallel form and split half

[2] Note Chapter 4 found that the wholistic-analytic dimension was reliable in a sample of 20, but these results need to be considered with caution given the small sample size in this study.

reliability analysis of the verbal-imagery and wholistic-analytic style ratios were low (verbal-imagery ratio Mean r = .21; wholistic-analytic ratio Mean r = .39). Furthermore, Chapter 3 showed that doubling the length of the verbal-imagery dimension did not greatly improve the reliability of the verbal-imagery ratio (Mean r= .33), whereas doubling the length of the wholistic-analytic dimension did (Mean r = .64). These results suggested that an extended version of the wholistic-analytic dimension of the CSA is a reliable and potentially useful style measure, but that the verbal-imagery dimension needed to be reviewed. This chapter has presented and tested an alternative to the verbal-imagery dimension of the CSA: the VICS. The findings of this thesis have shown that the VICS is more reliable and internally consistent than the verbal-imagery dimension of the CSA and confirmed the low reliability of the CSA's verbal-imagery dimension. The reliability of the VICS suggests however that the lack of stability on the verbal-imagery dimension on the CSA was not because this dimension did not exist or was not stable, but because of the way the CSA attempted to measure the dimension.

There is however a considerable amount of research that still needs to be conducted on the VICS. As Cattell (1957) said "the pragmatic proof that a thing 'works' carries the sure implication that we have something caught in our scientific net, but this may still leave us a long way from landing the catch" (p.5). Too often style researchers publish new tests and then abandon further careful investigation into the psychometric properties of the tests (Curry, 1990a).

More research on the VICS needs to be conducted in a number of areas. The first step is to investigate whether the VICS is independent from other potentially related constructs. Chapters 6, 7 and 8 will investigate the relationship that the VICS and the Extended CSA-WA have with established measures of personality, intelligence and other style related constructs.

Chapter 6

The Validity of the VICS and the Extended CSA-WA

6.1 Introduction

Furnham (2001) sets a challenge for the developers of cognitive style tests.

> "Even if styles exist and determine, in part, the learning (however defined and measured) that takes place in social behaviour, few would argue that they are the only - or the most important - factor that determines learning. The question then needs to be asked whether the amount of variance accounted for by this factor is so small as to be trivial, or, indeed, a major central factor. Do styles have incremental validity?" (p.292).

In other words, Furnham believes that a crucial part of any test development is the demonstration that it contributes something new to the field or, put another way, that other established tests or measures could not do the job better. In order to investigate whether a test can contribute something beyond that of established measures, it is important to identify potential correlates with the test and then to investigate their degree of relationship.

Testing and identifying all the possible correlates with cognitive styles is not an easy job. Many different measures of style have been proposed and many related constructs have been proposed. A model which helps show some of the more established relationships cognitive styles might have has been put forward by Furnham (1995) (see Figure 6.1 below). Furnham notes that there is much we do not know about this model, such as how the variables are measured and defined, if there are any feedback loops or bi-directionality, the degree of association between the model's components and what we mean by learning/cognitive style/methods. Despite the model having so many uncertainties, this type of model is implicit in many style studies.

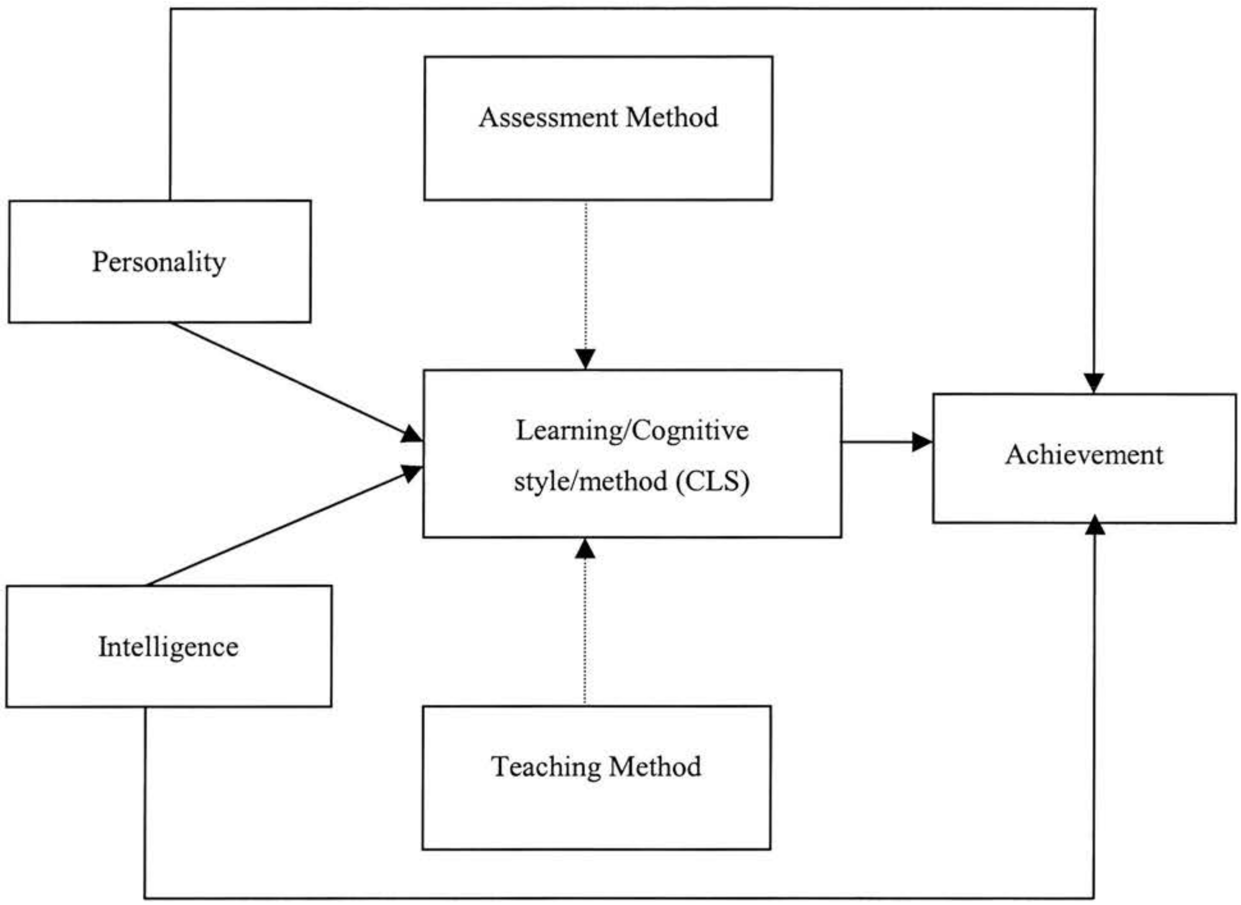

Figure 6.1
A proposed model for the role of cognitive and learning style (Furnham , 1995).

The model suggests that there are essentially four key factors (assessment method, personality, intelligence and teaching methods) which affect or somehow modify learning or cognitive styles and that any one of these factors, in association with style, will affect academic achievement. This model therefore suggests that if a researcher wants to establish a new model or test of style, it is important that the relationships the style has with these factors are investigated.

Typically style research has been divided into two main groups, which are also indicated in the model. The first group consists of studies which have focused more on the practical applications or external validity of styles (e.g., Pheiffer, Andrew & Green, 2002; Sadler-Smith & Riding, 1997; Riding & Grimley, 1999; Berings & Poell, 2002). In particular, they have investigated how assessment methods and teaching methods interact with an individual's cognitive style to affect academic achievement. The underlying aim is to try to find practical ways to increase or improve academic or job success. The second, more theoretical and often neglected group of research, has focused on the relationship that cognitive styles have with personality and intelligence (e.g., Furnham, 1992, 1995, 1996, 2001; Glicksohn & Golan, 2001; Jackson & Lawty-Jones, 1996; Riding & Wigley, 1997; Riding & Pearson, 1994). This research has stirred up debate which, in its extreme forms, suggests one of two things. One is that cognitive style measures are not needed as personality and intelligence explain more than cognitive styles do and are better predictors of academic achievement (e.g., Jackson & Lawty- Jones; Furnham, 1992). The other extreme is that personality and intelligence are completely separate and independent from cognitive and learning styles (Riding & Rayner, 1998; Riding, 1997).

The personality and intelligence factors identified in Furnham's (1995) model are relatively easy to measure. This is because there are many established personality and ability tests that have the backing of a substantial amount of empirical research. However, the cognitive/learning style construct that these factors feed into remains a large black box. Several attempts have been made to give this black box some structure. A variety of models have been proposed, most have an all pervasive, innate cognitive type style at one end and specific, teachable and changeable skills at the other (Adey et al., 1999). The most frequently cited model is Curry's (1983) Onion Model, which breaks styles down into three groups: Cognitive Personality Styles, Information Processing Models and Instructional Preference Models (see Chapter 10 for more details). If Curry's style layer model is correct, then it should be possible to show that a measure of cognitive personality style, such as the VICS and the Extended CSA-WA, is also separate from information processing and instructional preference models.

Overall, Furnham's and Curry's models provide an ideal framework in which to investigate the validity of the new VICS and Extended CSA-WA. Testing every aspect of this model is an enormous task. Chapter 7 will briefly re-examine the reliability of the VICS and the Extended CSA-WA, this time in a sample of 100 participants. The same sample will then be used in Chapters

8-11 to examine some of the more important aspects of the VICS's and the Extended CSA-WA's validity.

6.2 Study Aims and Objectives

Riding (1997) succinctly outlines six criteria that cognitive styles should meet in order to demonstrate construct validity. In essence, these criteria combine the important style related factors previously identified by Curry (1983) and Furnham (1992) mentioned above. Using Riding's (1997) construct validity criteria as a starting point, Chapters 8-11 aim to demonstrate that the VICS and the Extended CSA-WA dimensions are:

1. Independent from one another
2. Independent from personality
3. Separate from intelligence
4. Fulfilling the criteria of a style
5. Related to observed behaviour

The only construct validity criterion of Riding's not to be examined in this study is the relationship between cognitive styles and physiological measures.

Evidence that the VICS and Extended CSA-WA tests meet these criteria is important if they are to be accepted as psychometric tests that have the potential to make a real contribution to our understanding of individual differences in learning and achievement. Therefore, Chapter 8 will investigate the relationship between cognitive style and personality, Chapter 9 will investigate the relationship between cognitive style and intelligence, Chapter 10 will investigate the relationship between cognitive style and information processing and instructional preference measures of style and Chapter 11 will investigate whether cognitive style is manifested in observed behaviour.

Only a brief overview of the method used in Chapters 7-11 will be given below. A more specific and detailed description of the tasks, along with the results and a discussion will be given in each chapter.

6.3 Validity Study Method Overview

6.3.1 Participants

In this study there were 116 participants (24 males and 76 females). Dyslexics, English second-language speakers, subjects who failed to return for the second session and those who showed an obvious lack of concentration or motivation were excluded from the analysis making the final sample size 100. All participants were students from the University of Edinburgh and they were paid £10 for their participation in two 90 minute sessions. The mean age of participants was 20 years (SD = 4.06; Range 18-57) and the majority of them were right-handed (93%).

6.3.2 Procedure

The study consisted of two sessions. Each session lasted approximately 90 minutes. Participants were tested individually in a quiet room and were given a short break between each task and a longer break half way through the session.

In session 1 participants completed three tests of cognitive style: the VICS test, Riding's (1991, 1998) CSA and the Extended CSA-WA. They also completed one measure of personality (International Personality Item Pool [IPIP], Goldberg, 1999), one information processing measure (Approaches and Study Skill Inventory for Students [ASSIST]; Tait, Entwistle & McCune, 1998) and one Instruction Preference Inventory (Sadler-Smith & Riding, 1999). Finally the participants were given four measures of ability selected from the Exstrom, French, Harman, and Dermen (1976) Kit of Factor-Referenced Cognitive Tests.

At session 2 approximately one week later (mean 20 days; median = 20 days, mode = 7 days, range = 6-182 days), participants were asked to complete the three tests of cognitive style again in the same order as above to check for reliability. They were then given two further measures of personality (Impulsiveness IVE Questionnaire and the EPQ-R short form, both by Eysenck and Eysenck, 1991) and one test of instructional/environmental preference (Productivity Environmental Preference Survey [PEPS]; Dunn, Dunn & Price 1996). Finally the participants were given a further four measures of ability also taken from the Exstrom et al. (1976) Kit of Factor-Referenced Cognitive Tests.

At the end of session 2, subjects were given feedback on their personality according to the IPIP. They were then asked to select one of three feedback sheets on cognitive style. The feedback sheets contained the same information but were formatted differently (more details will be given in Chapter 11). The experimenter then explained the concept of cognitive style to the participant and discussed the participant's preferred style with them based on the results of the VICS and the Extended CSA-WA.

The Validity of the VICS and the Extended CSA-WA

Chapter 7

Reliability of the VICS, Extended CSA-WA and CSA in a sample of 100 participants

7.1 Introduction

Chapters 3 and 5 outlined in detail the nature and the reliability of the CSA, Extended CSA-WA and VICS tests using results from two experiments involving 50 participants. Overall, the results of these chapters indicated that the verbal-imagery dimension of the new VICS and the new wholistic analytic dimension of the Extended CSA-WA were more reliable than the same dimensions measured on Riding's (1991) original CSA. The only exception to this was Chapter 4 which, in a sample of 20 participants, found the CSA's wholistic-analytic dimension ratio was reliable at retest ($\underline{r} = .7$). Although this result was promising, it needs to be confirmed in a larger sample. Using a sample of 100 participants, this chapter aims i) to re-examine the reliability of the CSA's wholistic-analytic dimension and ii) to replicate the findings of chapters 3 and 5 with respect to the CSA's verbal-imagery dimension, the Extended CSA-WA and the VICS (using an improved VICS) in a larger sample. Brief details of the changes made to the VICS are given below. Following this, the reliability and internal consistency of the VICS, Extended CSA-WA and the verbal-imagery and wholistic-analytic dimension of the CSA are revealed for a sample of 100 participants.

7.2 Method

7.2.1 Participants

One hundred participants took part in the study. Details about them are given in Chapter 6 section 6.3.1.

7.2.2 *Stimulus materials*

The stimuli used in the verbal-imagery and wholistic-analytic dimension of the CSA were exactly the same as Riding's (1991, 1998) original CSA test. Details of this test are outlined in Chapter 3.

The stimuli used in the Extended CSA-WA consisted of the stimuli from the wholistic-analytic dimension of Riding's (1991, 1998) original CSA and the wholistic-analytic stimuli of the CSA-B (see Chapter 3 for details).

The VICS test was similar to that outlined in Chapter 5 however, 11 changes were made to the stimuli. A complete list of the VICS stimuli used in this study can be seen in Table 7.1. A stimulus marked with a * indicates that it has changed since Chapter 5. Changes were only made to stimuli that were found in Chapter 5 to have an error rate of more than 11% at any one session. Some items with lower error rates were also changed in order to create new pairs, but no new objects (e.g. cat, ruler, leg etc.) were employed. Those stimuli that were changed were matched with different objects to create new stimulus pairs. In some situations, an object was used twice in two different pairings. This was done with the proviso that the repeated object was presented once on the left and then once on the right. For example the repeated word 'glove' occurred once as 'glove and kite' and once as 'sock and glove.' Table 7.1 also gives a list of the repeated items.

In order to see whether the verbal and imagery sections of the VICS still had similar levels of name and image agreement, frequency, familiarity and age of acquisition, the means, ranges and standard deviations for each of these factors were computed using the Snodgrass and Vanderwart (1980) norms. Overall, the results were in keeping with the findings outlined in Chapter 5. No significant differences were found between the man-made or natural stimuli for any of the above factors except complexity, where natural objects were found to be more complex than man-made objects (t [114] = -4.48, p <.001). This suggests that man-made objects such as a ruler or a spoon are perceived as less complex than natural objects such as a cat or a mushroom. Similarly, no significant differences were found between the bigger and smaller sized items on these factors except for complexity (t [102] = -5.63, p <.001) and familiarity (t [102] = 3.51, p = .001). Again, these effects suggest that larger objects are usually more complex, and less familiar objects (in terms of degree of contact) are often bigger (see Chapter 5 for more details).

In summary, the above findings show that despite making some changes to the VICS stimuli in this study, the properties of the VICS stimuli have remained the same between the verbal and imagery tasks and they are in keeping with those found in Chapter 5. Therefore, as in Chapter 5, it is possible to conclude that any differences in participant performance on the verbal and imagery tasks in this

Table 7.1

Items used in the VICS verbal and imagery tasks with N= 100. Items marked with a * indicate that they have been changed from the VICS in Chapter 5 study with N= 50.

		Natural	Man-Made	Natural & Man-Made	1 = 1st item smaller 2 = 2nd item bigger 3 = 3rd item the same
Man Made Items					
Ashtray Snowman	1		1		1
Ladder Balloon	2		1		1
Cup Bed	3		1		1
Belt Barrel	4		1		1
Key Bottle	5		1		1
Bowl Anchor	6		1		1
Broom Envelope	7		1		2
Bus Chain *	8		1		2
Candle Wheel	9		1		1
Chair Sock	10		1		2
Crown Scissors	11		1		2
Lamp Ring	12		1		2
Bell Cannon	13		1		1
Flag Button	14		1		2
Guitar Bread *	15		1		2
Glove Kite	16		1		2
Hat Guitar	17		1		1
Harp Helicopter	18		1		1
Toaster Screw *	19		1		1
Drum Comb	20		1		2
Screwdriver Skirt *	21		1		1
Stool Ruler	22		1		2
Swing Spoon	23		1		2
Same Size Man-Made					
Pen Fork	24		1		3
Sock Glove	25		1		3
Pencil Toothbrush	26		1		3
Natural Items					
Penguin Butterfly	1	1			2
Flower Camel	2	1			1
Duck Carrot	3	1			2
Ostrich Turtle	4	1			2
Dog Tree	5	1			1
Cow Thumb	6	1			1
Fish Lion	7	1			2
Foot Giraffe	8	1			1
Bear Peanut	9	1			2
Giraffe Grapes	10	1			2
Tree Penguin	11	1			2
Lemon Kangaroo	12	1			1
Lips Duck *	13	1			1
Camel Nose	14	1			2
Pear Monkey	15	1			1

		Natural	Man-Made	Natural & Man-Made	1 = 1st item smaller 2 = 2nd item bigger 3 = 3rd item the same
Thumb Pineapple	16	1			1
Eye Pumpkin	17	1			1
Banana Rabbit	18	1			1
Snake Strawberry	19	1			2
Cat Mushroom	20	1			2
Turtle Potato	21	1			2
Ear Cat *	22	1			1
Owl Lemon	23	1			2
Natural Same Size					
Apple Onion	24	1			3
Rabbit Squirrel *	25	1			3
Zebra Horse	25	1			3
Mixed Category					
Nose Shoe	1			1	1
Pineapple Whistle *	2			1	1
Frog Ladder *	3			1	1
Peanut Umbrella	4			1	2
Tiger Chain *	5			1	2
Hammer Pear *	6			1	2

Repeated items

Man-made: ladder; guitar; sock; and glove.

Natural: turtle; peanut; penguin; giraffe; pineapple; rabbit; duck; cat; thumb; nose; pear; lemon; tree; and camel.

NB All stimuli that are repeated appear once on the left and once on the right.

study and any differences in responses to particular types of stimuli within each section of the test (man-made, natural, mixed, bigger, smaller or equal) are unlikely to be due to differences in name and image agreement, word frequency or age of acquisition.

7.2.3 Procedure

The VICS test was administered first, followed by the verbal-imagery dimension of the CSA and the wholistic-analytic dimension of the CSA. On completion of the wholistic-analytic dimension of the CSA, participants were asked to press the spacebar to begin the wholistic-analytic dimension of the CSA-B. As the wholistic-analytic test sections flowed into one another, the participants were unaware that they were responding to two separate wholistic-analytic tests (the original CSA and the CSA-B). The results from the verbal-imagery dimension and the first wholistic-analytic dimension were analysed as being from the CSA, then the results from the two wholistic analytic tests (one from the CSA and the other from the CSA-B) were combined to generate results for the Extended CSA-WA test. This order of test completion (VICS, CSA, Extended CSA-WA) was repeated at session 2 approximately a week later (mean 20 days, mode 7 days, range 6-182 days).

7.3 Results

The results section is divided into two parts. The first gives a brief outline of the errors made on the VICS. In order to examine the overall effect of changing some of the items. The second part will examine the reliability and internal consistency of VICS, the Extended CSA-WA and the CSA. The results of the anovas and the correlations between the median reaction times at session 1 and 2 for all the style tests were similar to those found in Chapters 3 and 5 and therefore, no detail will be given here.

7.3.1 VICS test error analysis

As shown in Table 7.2 the number of errors made by each subject at each session was low (2.2% for the verbal and 2.8% for the imagery section). In keeping with the findings of Chapter 5, no significant differences were found in the number of errors made at session 1 and session 2. In contrast to earlier findings, significantly more errors were made on the word stimuli than on the picture stimuli (ϕ^2 [23200] = .157, p <.001) and the second exposure to the verbal stimuli resulted in fewer errors (ϕ^2 [23200] = .016, p = .015). However, these effects are small given that the average participant made less than 3% errors. Overall, the low error rates indicate that the final sample of 100 participants seemed to understand the task and were well motivated.

Table 7.2

The number of errors on the VICS in each section (verbal, imagery), each stimulus type (natural, man-made, mixed, smaller, bigger, equal) and at each session and the percentage of participants errors who made those errors.

Test	Stimulus Type	Session 1	N	%	Session 2	N	%	Total	N	%
Verbal	Natural	No. of errors	56	1.2%	No. of errors	44	0.8%	No. of errors	100	0.7%
	Man-made	No. of errors	87	1.7%	No. of errors	78	1.5%	No. of errors	165	1.6%
	Mixed	No. of errors	86	7.1%	No. of errors	96	8.0%	No. of errors	182	7.6%
Total	Total Verbal	No. of errors	121	2.2%	No. of errors	126	2.2%	No. of errors	447	2.2%
Imagery	Bigger	No. of errors	184	3.5%	No. of errors	172	3.3%	No. of errors	356	3.4%
	Smaller	No. of errors	103	2.0%	No. of errors	104	2.0%	No. of errors	207	2.0%
	Equal	No. of errors	44	3.6%	No. of errors	31	2.6%	No. of errors	75	3.1%
Total	Total Imagery	No. of errors	174	3%	No. of errors	165	3.0%	No. of errors	638	3.0%

Only nine stimuli resulted in an error rate of greater than 10% at each session. This is half the number that was found in Chapter 5. Furthermore, only two stimuli ("Are Umbrella and Peanut natural ?" and "Are Guitar and Bread natural?") resulted in error rates of greater than 10% in both the word and picture form. This suggests that the items used in this study were generally less problematic than the items used in Chapter 5.

7.3.2 Stability of the style ratios

Table 7.3 below provides an overview of the reliability and internal consistency of the verbal-imagery and wholistic-analytic style ratios from the CSA, Extended CSA-WA, Extended CSA-VI and the VICS. More specifically, it shows the reliability of Riding's original CSA from Chapter 3 in a sample of 50 and from the current chapter with a sample of 100. It also shows the reliability and internal consistency of the Extended CSA-WA, Extended CSA-VI, and VICS style ratios in samples of 50 (taken from Chapters 3 and 5) and 100 (the current study). Internal consistency correlations are not reported for the CSA as there were not enough items to calculate this measure.

The results in Table 7.3 clearly show that the verbal-imagery dimension of Riding's original CSA is not a reliable test of cognitive style with correlations below .3 in both the samples of 50 and 100 participants. Riding's wholistic-analytic dimension is slightly more reliable, but still below acceptable levels for a psychometric test ($r < .5$). The extended versions of the CSA, which consisted of the CSA being combined with the CSA-B, to make a longer test, show that the reliability and internal consistency of the extended verbal-imagery ratio remains low (less than $\underline{r} = .3$). In contrast, the reliability of the extended wholistic-analytic dimension is considerably higher ($\underline{r} > .5$) in both samples of 50 and 100 participants and the internal consistency is about .7. This confirms the previous finding in Chapter 3 that the verbal-imagery dimension needed to be reviewed and that doubling the length of wholistic-analytic dimension made the dimension more stable. The table also shows the reliability and the internal consistency of the VICS ratios in samples of 50 and 100 participants. The test-retest reliability of the VICS ratios were high in both samples (around .55) and the internal consistency was even higher at about .8. Finally, this table notes that the correlation between the VICS ratios and the Extended WA ratios in the sample of 100 participants was less than $r = .1$ indicating that the ratios from the two dimensions were unrelated.

In conclusion, this analysis has confirmed the previous findings outlined in Chapters 3 and 5, but in a larger sample with an improved VICS test. This study has confirmed the finding that

Table 7.3

Table comparing the reliability and internal consistency of the CSA, Extended VI, Extended CSA-WA and the VICS in a sample of 50 participants (Chapter 3) and a sample of 100 participants (current chapter). Relevant results from Chapter 5 are also included. The results in bold indicate the most reliable and internally consistent measures.

Test	Chapter	N	Dimension	Reliability	Internal Consistency
CSA Original	3	50	Verbal-Imagery	.201	.307
	5	50	Verbal-Imagery	.302	
	7	100	Verbal-Imagery	.085	
	3	50	Wholistic-Analytic	.297	.764
	7	100	Wholistic-Analytic	.493	
Extended CSA (CSA-A & CSA-B)	3	50	Verbal-Imagery	.266	.205
	5	50	Verbal-Imagery	.174	.110
	3	**50**	**Wholistic-Analytic**	**.532**	**.685**
	7	**100**	**Wholistic-Analytic**	**.554**	**.721**
VICS Test	**5**	**50**	**Verbal-Imagery**	**.564**	**.720**
	7	**100**	**Verbal-Imagery**	**.549**	**.885**

NB. The correlations between the VICS and the Extended WA dimensions in the N= 100 sample was less than r = .1.

the Extended CSA-WA test ratios and the VICS ratios are more reliable than the original wholistic-analytic and verbal-imagery ratios of the CSA in samples of 50 and 100 participants. In addition, this study suggests that the high reliability of the CSA-WA ratio in Chapter 4 may have been due to the small sample size. Overall, these results suggest that the psychometric properties and the validity of the Extended CSA-WA and the VICS warrant further investigation. Chapter 8 will examine the relationship between the VICS and the Extended CSA-WA and personality.

Chapter 8

Style and Personality

8.1 Introduction

Guilford (1980) states that "cognitive styles are in the general family of personality traits" (p.715). Indeed most style and personality researchers agree that there is some conceptual overlap between them (Eysenck, 1978; Guilford, 1980; Messick, 1984; Furnham, 1995; Sternberg & Gregorenko, 1997). Where they differ, is on how closely they are empirically related and what degree of overlap is acceptable before one of the measures, typically the less established measure, becomes redundant. For example, Furnham (2001) has argued that many style measures explain no more than established personality tests and therefore their additive value is questionable. Indeed, Furnham (2001) has even suggested that 'style' may be the politically correct word for a 'trait'. On the other hand, researchers in favour of cognitive styles have argued that cognitive styles are the link between personality and cognition (Sternberg & Gregorenko, 1997) in that they develop around underlying personality trends (Messick, 1984), but they do not measure the same thing. For example, Riding and Wigley (1997) argue that cognitive styles affect personality but the low correlations between them suggest a different source of action.

Historically there has been little empirical research into the overlap between personality and styles. Researchers in both fields have tended to keep to themselves. Furnham (1995) notes that "it is usually only after a CLS (Cognitive Learning Style) has been well established and researched that investigators relate it to major theoretical systems in either personality or intelligence, but rarely both" (p.399). Consequently, many style measures have not been empirically compared with personality traits. Traits that have been compared with style have often shown some degree of association. For example, measures such as Witkin and Asch's (1948a; 1948b) Field Independence-Dependence;

Impulsivity and Reflectivity (Kagan, 1966); Honey and Mumford's (1982) Learning Style Questionnaire, Whetten and Cameron's (1984) Cognitive Styles Instrument, Kolb's (1976) Learning Style Inventory, Sternberg's (1997) Thinking Styles and the Myers-Briggs Type Indicator (Briggs & Myers, 1987) have all been found to have multiple correlations with established trait personality tests (Messick, 1984; Furnham, 1992; Furnham, 1996; Furnham, Jackson, Forde and Cotter, 2001; Sternberg & Grigorenko, 2001). Reported correlations between personality and style tend to range between .2 and .4 (Furnham, 2001) but correlations as high as .5 have been reported. For example, the trait impulsiveness correlated with Honey and Mumford's Activist style at $\underline{r} = .57$ ($\underline{p} < .001$) (Furnham et al., 2001) and the trait conscientiousness correlated with Sternberg's hierarchical style at $\underline{r} = .52$ ($\underline{p} < .01$) (Zhang, 2002).

Associations between personality and Riding's (1991, 1998) CSA test of verbal-imagery and wholistic-analytic styles have not been fully investigated. Two studies have been conducted, both of which have used the less stable style categories (verbal, bimodal, imagery, wholistic, intermediate, analytic) rather than the more reliable style ratios as their main measure of style. The first study (Riding, Burton, Rees & Sharratt 1995) divided the participants in to the six style categories (mentioned above) and these categories were then compared with personality ratings given by each subject's classroom peers. Subjects were rated on 9 characteristics (humorous, shy, outgoing, patient, quiet, lively, serious, helpful and sensible). The personality scores were then factor analysed to give three factors: active, modest and responsible. A significant interaction was found between participants' verbal-imagery style categories and the personality characteristics ($\underline{p} = .005$). No post-hoc t-tests were carried out, but analyses of the mean ratings on the personality characteristics indicated that verbalisers were more active than imagers and imagers were more responsible than verbalisers. No effect was found for the wholistic-analytic dimension.

In 1997 Riding and Wigley conducted a second study. This study compared each subject's cognitive style category on the CSA with personality measured by Eysenck and Eysenck's (1991) EPQ-R Short Scale and Impulsiveness (IVE) Questionnaire and the State and Trait Anxiety Inventory (Speilberger, 1977). Riding and Wigley found that none of the personality traits correlated more than .1 with the style ratios. Furthermore, a factor analysis of the personality scores gave four factors, none of which loaded more than .33 on the style ratios. Riding and Wigley did however find significant interactions between the style categories and their effect on neuroticism ($p = .039$) and impulsiveness ($p = .044$). More specifically, the results indicated an interaction with what Riding and Wigley describe as complementary and non-complementary style labels. Complementary styles are those that offer complementary facilities such as analytic-imagers and wholistic verbalisers. Analytic imagers have a complementary style because the imagery aspect of their style allows them to get a more global overview, which would not normally be associated with an analytical style. Wholistic-verbalisers are also complementary because the analytic property of verbalisation acts as a balance against the wholistic style. Non-complementary styles offer similar facilities and often intensify one another, such as wholistic-imagers and analytic verbalisers. Riding and Wigley argue that the style labels can be ordered on a complementary/non-complementary axis, with wholistic-verbalisers, who have a complementary combination, at one end and wholistic-imagers, who have the most unitary style, at the other (see Riding & Rayner, 1998 for more detail). Riding and Wigley found that those with complementary style labels were likely to be more neurotic. They argued that this was probably because those with complementary styles can switch between wholistic and analytic approaches to problems and may display more mood variability. In contrast, Riding and Wigley suggested that those with non-complementary styles were likely to be less impulsive, as analytics consider all possibilities and wholists see things in context. No post-hoc t-tests were conducted to confirm these associations between personality and style categories, nevertheless, these findings led Riding and Wigley to suggest that "physiological sources of personality are independent of cognitive style but are moderated by style in their effect on behaviour" (Riding & Rayner, 1998, p.112).

Overall, the definition of cognitive style suggests that there is some conceptual overlap between style and personality constructs. Furthermore, the findings of Riding et al. (1995) and the Riding and Wigley (1997) study suggest that there may be some empirical association between personality and the verbal-imagery and wholistic-analytic style dimensions on the CSA test, but the associations appear to be low and possibly indirect. However, the use of the style categories, rather than the ratios in both these studies suggests that the results of the interactions described above must be treated with caution. To date, no research has been conducted to look at the relationship between verbal-imagery and wholistic-analytic cognitive styles and the 'Big Five' model of personality traits (Riding, 1998). The 'Big Five' and Eysenck's three factor model (such as the EPQ-R) are the major personality models currently in use (Austin, Deary, Whiteman, Fowkes, Pedersen, Rabbit, Bent & McInnes, 2002). Therefore, the association of both personality models (EPQ and the Big Five) with verbal-imagery and wholistic-analytic cognitive style needs to be investigated.

Similar to the Riding and Wigley (1997) study, the current study was designed to investigate the relationship between personality measured by the EPQ-R Short Scale and Impulsiveness (IVE) Questionnaire and verbal-imagery and wholistic-analytic cognitive style. This study, also included a scale that measured the lexical ‘Big Five’ personality traits (taken from Goldberg’s (1999) International Personality Item Pool [IPIP]) and used the more reliable ratios from the VICS and Extended CSA-WA tests of verbal-imagery and wholistic-analytic cognitive style, rather than the CSA.

Goldberg’s (1999) lexical ‘Big Five’ is just one of the scales that has been developed from the International Personality Item Pool of 1,252 items. Public domain, parallel scales have also been developed for the 16PF, TCI, and HPI (Goldberg, in press). The overall purpose of the personality item pool is to encourage an “international effort to develop and continually refine a broad-band width personality inventory, whose items are in the public domain, and whose scales can be used for both scientific and commercial purposes” (Goldberg, in press, p.8). The hope is that if the scientific community combines its efforts, it should be able to devise instruments that will enable the field of personality to advance. In general, the IPIP scales have been found to correlate between .60 and .75 with their intended original counterpart which, when corrected for scale un-reliabilities, translates into correlations between .85 and .95 (Goldberg, in press). The IPIP 10-item lexical ‘Big Five’ scale used in the current study has a mean scale alpha of .84 (range .79-87). These findings indicate that the IPIP’s lexical ‘Big Five’ is a valid and suitable measure to compare with cognitive style in the current study.

8.2 Method

8.2.1 Participants

The same 100 participants took part in the study as mentioned in Chapter 6 section 6.31.

8.2.2 Apparatus

The VICS and the Extended CSA-WA test were presented using the E-PRIME computer program (more details can be found in Chapters 3 and 5). Participants were also asked to complete Eysenck and Eysenck’s (1991) EPQ-R Short Scale, Eysenck and Eysenck’s (1991) Impulsiveness (IVE) scale and Goldberg’s (1999) lexical ‘Big Five’ IPIP scale.

EPQ-R Short Scale measures Extroversion, Strong-mindedness, Emotionality and contains a Lie Scale. Each sub-scale consists of 12 items on a Yes/No dichotomous scale.

The Impulsiveness (IVE) Scale measures Impulsiveness, Venturesomeness and Empathy also on a dichotomous Yes/No scale. The impulsiveness and empathy scales consist of 19 items and the venturesomeness scale contains 16.

Goldberg's (1999) lexical 'Big Five' IPIP scale measures Extroversion, Agreeableness, Conscientiousness, Emotional Stability and Intellect/Imagination. Each scale is measured by 10 items on a Likert five -point scale, ranging from very inaccurate (1) to very accurate (5).

8.2.3 Design

This experiment was designed to investigate the correlation between cognitive style preference on the VICS and Extended CSA-WA test (measured at two points in time) and scores on the EPQ-R, IVE and the IPIP.

8.2.4 Procedure

Participants were tested individually in a quiet room. At session 1 each participant completed the VICS first followed by the IPIP questionnaire and the Extended CSA-WA. At session 2 participants were given the VICS again, followed by the EPQ-R and the IVE questionnaires. Then they were asked to complete the Extended CSA-WA test for the second time.

Instructions on how to complete the VICS and the Extended CSA-WA test were given before each task (see Chapters 3 and 5 for details). The personality questionnaire instructions were as specified by the test authors and were written on the participants' answer sheets. Participants were asked to read the instructions carefully before filling in the questionnaires.

8.2.5 Results

Table 8.1 below gives the means and standard deviations for each trait measured by the EPQ-R, IPIP and IVE personality tests. The mean trait scores for EPQ-R and IVE are similar to those reported by Eysenck and Eysenck (1991) for 20-30 year olds. No norms are available for the IPIP scales (http://ipip.ori.org.ipip/, 2002).

Correlations between participants' verbal-imagery and wholistic-analytic cognitive style ratios (measured by the VICS and the Extended CSA-WA test) and the EPQ-R, IVE and IPIP can be found in Tables 8.2 (Spearman's correlations can be found in Appendix 8).

The first four columns of Table 8.2 show that no personality measure correlated above .37 on the style ratios. In other words, the three personality tests explain no more than 10% of the style ratio variance. This indicates that the three personality measures are not measuring the same thing as the cognitive style ratios.

Furthermore, the four significant correlations that were found between personality and style were not consistent with the style ratio at both session 1 and session 2. More specifically, significant correlations were found between a verbal style at session 2 and agreeableness ($r = -.266$, $p = .024$), an imagery style at session 1 and empathy ($r = -.322$, $p = .001$), a wholistic style at session 1 and emotional stability (measured by the IPIP) ($r = -.276$, $p = .005$) and empathy ($r = .232$, $p = .021$) and a wholistic style at session 2 and strong-mindedness ($r = -.323$, $p < .001$).

As expected, emotional stability, which was measured on the IPIP and the EPQ-R, correlated highly ($r = -.807$, $p < .001$), as did extroversion, which was also measured on the IPIP and the EPQ-R ($r = .759$, $p < .001$). All other correlations between the personality traits measured by the three different personality measures were less than $r = .41$, indicating that the tests were orthogonal.

8.3 Discussion

This study has shown that verbal-imagery dimension of the VICS and the wholistic-analytic dimension of the Extended CSA-WA test show little to no correlation with personality as measured by the EPQ-R, IPIP and IVE. That is, no personality dimension correlated more than .37 with cognitive style and therefore, personality explained less than 10% of the cognitive style variance. Furthermore, no trait showed a consistent correlation with cognitive style over time and therefore, it is possible that the significant correlations that were found were type 1 errors.

These findings are important for four main reasons. First, they provide crucial support for the incremental validity of the VICS and the Extended CSA-WA as cognitive style tests; the VICS and the Extended CSA-WA are not measuring personality. Second, the use of Eysenck's three-factor model (measured in this study by the EPQ-R Short Scale) and the five-factor model (measured in this study by the IPIP) are, according to Austin et al. (2002), the major personality traits and the most important personality models currently in use. Therefore, establishing independence from these measures is a significant finding. Third, compared to other empirically tested style measures, the VICS and the Extended CSA-WA had considerably fewer significant correlations with personality. For example, this study only found two significant correlations between the big five and style (range .23 -.28), whereas

Table 8.1

Mean and standard deviations for participant trait scores on the EPQ-R, IPIP and the IVE.

TEST	Trait	Mean	Standard Deviation
EPQ-R	Extraversion	8.7	3.2
	Strong mindedness	2.6	2.6
	Emotional stability	5.7	3.3
	Lie scale	2.9	2.0
IPIP	Extraversion	35.8	8.3
	Agreeableness	42.2	5.9
	Conscientiousness	33.3	7.3
	Emotional stability	29.5	9.3
	Intellect/imagination	36.7	6.6
IVE	Impulsiveness	7.4	4.0
	Venturesomeness	9.3	4.2
	Empathy	14.8	3.8

Table 8.2 Pearson's Correlations (p values) between verbal-imagery and wholistic-analytic style ratios and IPIP, EPQ-R, and IVE personality scales. Correlations in bold show the significant correlations with cognitive style. Underline correlations are significant.

		1	2	3	4	5	6	7	8	9	10	11	12	13		14
1	VICS Verbal-Imagery (S1)															
2	VICS Verbal-Imagery (S2)	.549 (.000)														
3	Extended CSA-WA (S1)	.037 (.714)	-.085 (.400)													
4	Extended CSA-WA (S2)	.024 (.811)	.094 (.353	.554 (.000)												
5	Extraversion (IPIP)	-.050 (.616)	-.040 (.695)	-.126 (.211)	-.045 (.658)											
6	Agreeableness (IPIP)	-.189 (.060)	**-.226 (.024)**	-.028 (.782)	-.005 (.964)	.206 (.039)										
7	Conscientiousness (IPIP)	-.071 (.484)	-.119 (.238)	.126 (.213)	.077 (.446)	-.029 (.770)	.342 (.000)									
8	Emotional stability (IPIP)	.043 (.669)	-.119 (.239)	**-.276 (.005)**	-.083 (.489)	.362 (.000)	.228 (.022)	.114 (.254)								
9	Intellect/imagination (IPIP)	-.081 (.421)	.004 (.966)	-.011 (.916)	.033 (.741)	.310 (.002)	.143 (.155)	.137 (.172)	.138 (.168)							
10	Strong mindedness (EPQ-R)	.039 (.699)	.039 (.698)	**-.323 (.001)**	-.121 (.231)	-.050 (.621)	-.174 (.082)	-.191 (.056)	.067 (.506)	.040 (.689)						
11	Extraversion (EPQ-R)	.038 (.708)	.096 (.343)	-.104 (.303)	-.076 (.450)	.759 (.000)	.184 (.065)	-.026 (.797)	.313 (.001)	.221 (.026)	-.200 (.045)					
12	Emotional stability (EPQ-R)	-.017 (.864)	.017 (.870)	.176 (.080)	.057 (.571)	-.395 (.000)	-.146 (.146)	-.158 (.115)	-.807 (.000)	-.042 (.679)	-.059 (.555)	-.308 (.002)				
13	Lie Scale (EPQ-R	-.069 (.492)	-.064 (.530)	-.017 (.864)	-.040 (.692)	-.144 (.150)	-.039 (.701)	.039 (.698)	.030 (.769)	-.139 (.165)	.078 (.440)	-.039 (.696)	-.002 (.985)			
14	Impulsiveness (IVE)	.002 (.983)	.151 (.136)	-192 (.057)	-.049 (.629)	.243 (.015)	-.212 (.034)	-.361 (.000)	-.034 (.738)	.078 (.440)	.210 (.036)	.216 (.031)	.011 (.915)	-.115 (.253)		
15	Venturesomeness (IVE)	.041 (.688)	.139 (.169)	-.154 (.128)	-.081 (.428)	.106 (.292)	.105 (.296)	-.107 (.289)	.318 (.001)	.121 (.231)	.326 (.001)	.256 (.010)	-.226 (.024)	.048 (.638)	.263 (.008)	
16	Empathy (IVE)	**-.322 (.001)**	-.195 (.053)	**.232 (.021)**	.188 (.062)	-.015 (.883)	.180 (.072)	-.031 (.761)	-.224 (.025)	.113 (.265)	-.182 (.070)	-.015 (.885)	.281 (.005)	.037 (.715)	.051 (.617)	-.036 (.719)

six were found with the LSQ (range .15-.28), nine with the MBTI (range .17-.70) and 22 with Thinking Styles (range .16-.51) (see Furnham et al., 2001; Zhang 2002 for more details). Fourth, unlike the LSQ, MBTI and Thinking Styles, no single personality test and all its sub-scales correlated with style (see Furnham et al., 2001, Zhang, 2002). More specifically, in the current study, only two traits from the IPIP (agreeableness and emotional stability), one trait from the EPQ-R (strong mindedness) and one trait from the IVE (empathy) correlated with style. Therefore, no single personality measure explains much of the style variance. Note also that emotional stability was measured twice, once by the IPIP and once by the EPQ-R, but only the IPIP trait measure correlated with style. This lack of consistency further suggests that this correlation may have been a type one error.

The only consistent correlation across time was the Spearman's correlations between empathy and a wholistic style (mean $\underline{r}$ = .26, see Appendix 4) and empathy and an imagery style (mean $\underline{r}$ = - .26, see Appendix 4)[3]. To some extent these relationships seem logical. A wholistic person is typically defined as someone who likes to see the bigger picture and therefore is perhaps less self-focused, possibly even vague (Riding et al., 1995). Similarly, imagers are thought to be more polite, restrained and reflective (Riding, et al., 1995) which may also give them more empathetic tendencies. It is important to remember that these correlations are low, explaining no more than 10 % of the variance and they were not consistent over time or when Pearson's correlations were calculated (see Table 8.2)

As mentioned above, previous research by Riding and Wigley (1997) also examined the relationships between verbal-imagery and wholistic-analytic cognitive style (measured by the CSA) and personality measured by the EPQ-R Short Scale and the Impulsiveness (IVE) Questionnaire. Although the current study used the VICS and the Extended CSA-WA to measure verbal-imagery and wholistic-analytic cognitive style, a comparison between the two studies is still appropriate (see Table 8.3 below). The correlations that Riding and Wigley found between the CSA style ratios and the personality traits were lower than the current study's session 1 style ratios but they were similar to the current study's session 2 style ratios. Furthermore, most of the correlations in both studies were in the same direction. Unfortunately, Riding and Wigley only gave p values for the correlations that were significant at .001 level. If this significance level is adopted for the current study, none of the

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[3] A negative correlation indicates a correlation with the imagery end of the verbal-imagery dimension and with the analytic end of the wholistic-analytic dimension. A positive correlation would indicate a relationship with the verbal end of the verbal-imagery dimrension or with the wholistic end of the wholistic-analytic dimension

correlations found between the VICS, Extended CSA-WA and personality would have been significant either. Despite differences in the presentation of results, both Riding and Wigley's and the current study suggest that the EPQ-R and the IVE personality tests can not account for the differences in verbal-imagery or wholistic-analytic cognitive style.

In conclusion, this study has shown that the VICS and the Extended CSA-WA test appear empirically to be largely separate from personality and therefore they should not be replaced by trait personality tests. The next chapter will examine the relationships that the VICS and the Extended CSA-WA have with cognitive ability.

Table 8.3
Comparison between Riding and Wigley's (1997) study and the current study's in terms of the correlations between verbal imagery (VI) cognitive style and wholistic-analytic (WA) cognitive style and personality measured by the EPQ-R and IVE.

Personality Test	Riding and Wigley		Current Study Session 1		Current Study Session 2	
	VI	WA	VI	WA	VI	WA
EPQ-R						
Strong-mindedness	.03	-.03	.04	-.32 *	.04	-.12
Extraversion	-.07	.04	-.04	-.10	.10	-.08
Emotional stability	.01	-.04	-.02	.18	.02	.06
IVE						
Impulsive	.10	-.01	.00	-.19	.015	-.05
Venturesomeness	.00	-.08	.04	-.15	.014	-.08
Empathetic	-.01	.03	-.32**	.23*	-.20	.19

NB. Only p values less than .001 are given for the Riding and Wigley data. For the current study * = correlations that are significant at the .05 level, ** = correlations significant at the .01 level.

Chapter 9

Style and Intelligence

9.1 Introduction

Several attempts have been made to distinguish style from intelligence. Indeed Kogan (1973) suggested that styles could be classified in terms of how removed they are from the construct of ability and by the way that they are measured (cf. Sternberg 2001; Guilford, 1980). Kogan identified three classes of style. The first class puts cognitive style very close to abilities and is measured in terms of performance accuracy. In this case, Kogan notes that this class is not really a style, the term is used only because authors using this type of measurement have used this term (e.g., field dependence-independence). The second class is not measured by accuracy but there is a value distinction, whereby performance at one end of the dimension is valued more than the other end (e.g., tests of fluency and flexibility). The final class is seen as the most authentic cognitive style, as neither accuracy nor judgement is used in the procedure (e.g., style questionnaires such as Honey and Mumford's LSQ would be placed in this category).

Messick (1976) suggested a similar but more detailed distinction between cognitive style and ability. In brief, Messick argued that abilities measure maximal performance, are unipolar, value directional, domain specific, enabling variables that are interested in the question of 'how much' and 'what' is done. In contrast, cognitive styles measure typical performance, are bipolar or bifurcated, are value differentiated, cut across domains and are organising variables that focus on 'how' something is done (see Chapter 1 for more details on this theoretical distinction).

In contrast to the somewhat blurred distinction made between personality and style, Kogan (1973) and Messick (1976) place true cognitive styles clearly away from cognitive abilities. Kogan and Messick however, both agree that there are many measures that are labelled style that conceptually fail to meet their criteria of a proper style.

There have also been some attempts in the literature to integrate style and abilities. For example, Guilford (1980) suggested a model that related cognitive style to his model of the structure of the intellect (SI). Guilford argued that some cognitive styles relate to several SI abilities and therefore he suggested that cognitive styles might be higher order abilities. For example, Guilford suggested that field independence could be a broad transformation ability, which covers all operations and all content areas. The suggestion that styles may be metastrategies or higher order processes that recruit lower order abilities has also been suggested by Miller (1987), Royce and Powell (1983) and Tiedemann (1989).

Despite other researchers suggesting that styles and abilities could be linked in a higher order framework, most researchers today believe it is more important to show that style measures are independent of ability. Messick's (1976) conceptual criteria for distinguishing style and ability are the standard to which most styles are compared. Styles that fail to meet these criteria are frequently criticised. The most common trap that many styles fall into is that they measure performance accuracy rather than a preference (see Tiedemann, 1989 for a review).

At face level it is relatively easy to determine whether a style measure meets Messick's (1976) conceptual criteria for a cognitive style, but few studies have been conducted to empirically investigate the relationships between style measures and ability tests. The notable exception to this is Witkin et al.'s (1962) field-independence style, which has been heavily criticised for being too close to ability. McKenna (1984) systemically showed how field independence failed to meet Messick's (1976) conceptual criteria and goes on to empirically show substantial correlations with general intelligence and performance ability. Studies that have investigated the relationship between field independence and ability have typically found correlations between .4 and .6 (see Sternberg & Grigorenko, 2001).

Riding and Pearson (1994) and Riding and Agrell (1997) have empirically investigated the relationship between ability and verbal-imagery and wholistic-analytic cognitive styles. Both studies used Riding's (1991) CSA to measure cognitive style. Riding and Pearson compared cognitive style preferences of 12-13-year-olds to their performance on the British Ability Scales and a test of Embedded shapes, while Riding and Agrell compared the cognitive style of 14-16-year-olds to their performance on the Canadian Test of Cognitive Skills. The abilities tested by these scales and their correlations with verbal-imagery and wholistic-analytic cognitive style are low (less than .11) and can be seen in Table 9.1 below. It is possible that the low correlations found between ability and verbal-imagery and wholistic-analytic style were in part due to the ability tests that were chosen. Ideally, to test whether a cognitive dimension is independent of ability, an ability that to some extent resembles the style dimension should be selected, e.g. a spatial or imagery task could be used to test the relationship of imagery style with ability. With the exception of the Embedded Figures Test, Riding and Pearson (1994) and Riding and Agrell (1997) appear not to have chosen abilities scales that related to each style they were measuring.

The current study investigated the relationship between the VICS verbal-imagery style and Extended CSA-WA wholistic-analytic style and eight measures of ability. Two ability tests were chosen that were thought to have links with each of the four styles. Table 9.2 gives a description of each ability test chosen and the style group that it was intended to test.

Another, more indirect, way of looking at ability is to examine educational achievement. The study of educational achievement is difficult because of variable subject or course content, the differing ways the subjects or courses can be taught and the different methods of assessment (Riding & Rayner, 1998). To date, no large-scale study on verbal-imagery and wholistic-analytic style dimensions and attainment has been conducted, although studies looking at attainment and other style measures have been carried out (e.g., Armstrong, 2000 using the CSI). However, Riding & Rayner (1998) conducted a meta-analysis of three studies on 16-year-olds' style and GCSE attainment in English, Maths and Science. The results indicated that wholistic-imagers (who have a non-complementary style –see Chapter 8) tended to show the

Table 9.1
Table showing the correlations that Riding and Pearson (1994) and Riding and Agrell (1997) found between wholistic-analytic and verbal-imagery cognitive style measured on the CSA and ability measured by the British Ability Scale and the Canadian Test of Cognitive Skills.

	CSA-WA	CSA-VI
British Ability Scale (short form) (Riding and Pearson, 1994)		
IQ	.05	.12
Recall	-.01	.12
Similarities	-.03	.01
Matrices	-.10	.04
Speed of Information Processing	.07	.02
Embedded Shapes	.04	-.04
Canadian Test of Cognitive Skills (Riding and Agrell, 1997)		
Sequences	.01	-.10
Analogies	-.01	-.05
Verbal Reasoning	-.02	-.10
Memory	-.03	-.03

Note: Riding and Pearson's (1994) study only reports the significance of correlations that reach the .01 level. Riding and Agrell's (1997) study only reports the significance of correlations that reached the .001 level. None of the correlations above are identified as reaching these levels of significance.

poorest performance particularly in English and Science and the wholistic verbalisers (who have a complementary style) tended to perform the best in English, Science and Maths.

This study investigated the relationship between cognitive style, ability and academic attainment in Psychology 1 on a multiple choice degree exam. This was done, by correlating exam scores of 45 Psychology 1 participants in the current study with their ability scores and their style ratios. The results will be presented below.

Overall, like the personality study in Chapter 8, this study was conducted to see whether ability test scores could account for the VICS verbal-imagery and Extended CSA-WA wholistic-analytic cognitive style variance, or whether style was independent of verbal, imagery, wholistic, and analytic ability. Furthermore, the relationship between style, ability and academic attainment of the first year psychology participants in this study was investigated.

9.2 Method

9.2.1 Participants

The same 100 participants took part in the study as outlined in Chapter 6 section 6.31. As noted previously, the sample had a restricted age range (18-57 years, mean = 20 years) and participants were all students from the University of Edinburgh. Therefore, the average ability level of the sample was probably high. Exam scores were also collected for 45 of the first year psychology participants. Some participants did not complete all the tasks in this study due to time constraints.

9.2.2 Apparatus

The VICS test and the Extended CSA-WA test were presented as above. A selection of eight cognitive ability tests were chosen from the well-validated Kit of Factor Referenced Cognitive Tests (Ekstrom, French, Harman & Dermen, 1976). The ability tests were chosen to cover a range of abilities that seemed relevant to the dimensions of the four styles. A brief description of each test, how long the participants had to complete the task, and the proposed associated style dimension is given in Table 9.2 below.

Table 9.2
Table giving a description of the ability tests selected from Ekstrom, French, Harman and Dermen's (1976) Kit of Factor Referenced Cognitive Tests. The proposed relevant style group is also identified.

Group	Test	Duration	Description of Test
Verbal	Extended Vocabulary	8 min	Requires identification of the correct meaning of a word given four options.
	Advanced Vocabulary	12 min	Requires identification of the correct meaning of a word given four options.
Imagery	Card Rotation	6 min	Subject mentally rotates a shape to identify if it is the mirror image or the same as its partner.
	Paper Folding	6 min	The subject is presented with pictures of paper folded with a hole in and asked to identify the unfolded paper from several options.
Wholistic	Gestalt Completion	6 min	Incomplete pictures of objects are presented and participants are required to name the objects.
	Controlled Association	12 min	Participants are given eight words and required to think of as many related words as possible to the eight given.
Analytic	Finding A's	4 min	A list of words is given and participants are required to identify the words which contain the letter 'a'.
	Hidden Figures test	6 min	Participants are presented with a simple shape which they are required to identify within more complex shapes.

9.2.3 Design

This experiment was designed to investigate the correlations between cognitive style preference on the VICS and the Extended CSA-WA (measured at two points in time) with their scores on the verbal, imagery, wholistic and analytic ability tests. The association between style, ability and academic achievement was also investigated for 45 of the 100 participants.

9.2.4 Procedure

Participants were tested individually in a quiet room. At session 1, each participant completed the VICS test and the Extended CSA-WA test (details of this procedure are given above). Participants then completed four timed ability tests (the Finding A's test, the Controlled Association test, the Card Rotation test, and the Advanced Vocabulary test). Participants were instructed to read the ability tests' instructions and complete the practice items before commencing with the tests proper. Each ability test consisted of two parts and a short break was given in between each task. Session 2 was exactly the same as session 1, except that four new timed ability tests were given (the Gestalt Completion test, the Hidden Patterns test, the Paper Folding test and the Extended Vocabulary test). Finally, the experimenter asked the first year participants for written permission to access their official psychology 1 multiple choice exam marks. They were told that no other information would be sought.

9.3 Results

Table 9.3 below gives the numbers of subjects who completed each ability task and the mean, median, minimum and maximum scores on each ability test. The results suggest that there was a broad range of ability on most of the cognitive tasks. Maximum scores were reached for the Mental Rotation, Paper Folding and for part 2 of the Gestalt Completion task.

The part 1 and part 2 ability test scores were combined to give one score or total for each ability test. These scores were then correlated with participants' cognitive style ratios. The results can be seen in Table 9.4 (Spearman's correlation coefficients and the correlations between style and the part 1 and part 2 ability tests are given separately in Appendix 5).

Table 9.3
The number of participants who completed each ability task and the mean median, minimum, maximum and standard deviations of the participant scores on each cognitive ability test.

Ability	Test and Session	N	Mean	Med	Min	Max	.SD
Verbal	Advanced Vocab, Part 1, S1	99	10	10	2	19	3.6
	Advanced Vocab, Part 2, S1	99	10	10	1	20	4.4
	Extended Vocab, Part 1, S 2	96	9	9	3	20	2.9
	Extended Vocab, Part 2, S2	96	8	7	1	17	3.0
Imagery	Mental Rotation, Part 1, S1	100	58	58	25	80	15.4
	Mental Rotation, Part 2, S1	100	55	57	24	80	13.1
	Paper Folding, Part 1, S2	100	6	7	1	9	2.4
	Paper Folding, Part 2, S2	100	7	7	2	10	1.9
Wholistic	Controlled Association, Part 1, S1	95	10	9	1	22	4.2
	Controlled Association, Part 2, S1	95	11	11	0	22	5.0
	Gestalt Completion, Part 1,.S2	100	7	8	3	9	1.5
	Gestalt Completion, Part 2, S2	100	6	7	1	10	1.9
Analytic	Find A's, Part 1, S1	100	28	28	12	64	8.4
	Find A's, Part 2, S1	100	28	27	10	64	8.4
	Hidden Pattern, Part 1, S2	99	115	111	57	186	24.4
	Hidden Pattern, Part 2, S2	99	114	110	67	186	23.8

Table 9.4
Pearson's correlations (p values) between VICS verbal-imagery style ratio and Extended CSA-wholistic-analytic style ratio and the total ability scores for eight ability measures. Underlined correlations are significant. Correlations underlined are significant. Correlations in bold show the significant correlations between ability and style.

		1	2	3	4	5	6	7	8	9	10
1	VICS Verbal-Imagery, S1										
2	VICS Verbal Imagery, S2	**.549 (.000)**									
3	E CSAWholistic-Analytic, S1	.037 (.714)	-.085 (.400)								
4	E CSA-Wholistic Analytic, S2	.024 (.811)	.094 (.353)	.554 (.000)							
5	Total Vocabulary	-.026 (.801)	.119 (.242)	-.034 (.739)	-.001 (.994)						
6	Total Card Rotation	.079 (.433)	**.245 (.014)**	-.052 (.606)	-.114 (.258)	.139 (.168)					
7	Total Paper Folding	-.026 (.794)	**.221 (.027)**	-.061 (.544)	.050 (.619)	.090 (.372)	.361 (.000)				
8	Total Controlled Association	.054 (.604)	.134 (.195)	-.004 (.971)	-.078 (.454)	.362 (.000)	.268 (.008)	.265 (.009)			
9	Total Gestalt Completion	-.035 (.733)	.160 (.112)	-.265 (.008)	-.075 (.460)	.162 (.108)	.298 (.003)	.316 (.001)	.068 (.513)		
10	Total Find A's	-.131 (.195)	-.050 (.625)	.048 (.635)	.054 (.595)	.059 (.557)	.286 (.004)	.208 (.037)	.153 (.136)	.169 (.091)	
11	Total Hidden Figures	-.038 (.712)	.004 (.972)	.006 (.952)	-.001 (.991)	.102 (.317)	.262 (.008)	.271 (.006)	.284 (.005)	.170 (.092)	.282 (.004)

The first four columns of Table 9.4 show the relationships between cognitive style and the ability measures. No ability measure correlated more than .27 on style. Furthermore, there were no consistent, significant correlations between ability and style at either session 1 or session 2. The significant correlations with style that were found were between Card Rotation and a verbal style at session 2 (r = .25 p = .014), Paper Folding and a verbal style at session 2 (r = .22, p = .027) and Gestalt Completion and a wholistic style at session 1 (r = -. 27, p = .008).

Other significant correlations were found between the total ability tests scores namely: Controlled Association with the Vocabulary Tasks, Card Rotation and Paper Folding; Gestalt Completion with Card Rotation and Paper Folding; and Hidden Figures with Rotation, Paper Folding, Controlled Association and the Finding A's tasks (see Table 9.4). Correlations between parts 1 and 2 of the verbal, imagery and analytic ability tests were high (all above r =. 61) (see Appendix 5). The wholistic tests (Gestalt Completion and Controlled Association) had lower correlations between each part (Controlled Association r = .445, Gestalt Completion r = .375). Analysis of the correlations within each ability grouping (i.e., verbal, imagery, wholistic, analytic) showed that the verbal ability tests were the most similar (mean r = .64). The ability test within the imagery group and analytic group were also related, but to a lesser degree (imagery mean r = .43, analytic mean r = .38) and the wholistic tests were poorly related (mean r = .12) (see Appendix 5).

Factor analysis of the ability tests was conducted to see if the ability tests were measuring any higher order mental ability factors. The total scores for each ability test were subjected to a principal components analysis. Examination of the scree slope (see Appendix 5, Figure 1) suggested the existence of either two or three factors with two factors having an eigenvalue greater than 1. The first two factors together explained 50% of the variance. The third factor explained 14% of the variance. The two and three factor solutions were subjected to oblique rotation. The two factor solution gave two clear categories of ability. The first factor was a spatial ability or speed factor consisting of the Rotation, Paper Folding, Gestalt Completion, Hidden Figures and Finding A's tests. The second factor was a verbal ability factor consisting of the Vocabulary and Controlled Word Association tests. The three factor oblique solution gave factors of spatial ability (Rotation, Paper Folding and Gestalt Completion), verbal ability

(Vocabulary, Controlled Word Association) and analytic ability (Hidden Figures, Finding A's) (see Appendix 5, Table 4 for the factor loadings).

The two extracted ability factors (spatial/speed and verbal) which were found to be unrelated (r = .2) were then correlated with the VICS and Extended CSA-WA ratios at session 1 and session 2. No significant correlations were found between style and the two ability factors.

The two extracted ability factors were also correlated with the median reaction times to the verbal and imagery sections of the VICS and the wholistic and analytic sections of the Extended CSA-WA to see whether there was an association between raw reaction times and ability (see Table 9.5). Table 9.5 shows that the spatial-speed factor (which was also the first factor extracted and therefore may also be a g factor) significantly correlates with seven out of the eight style dimension reaction times, whereas the verbal ability factor shows only two significant correlations with the reaction times.

Finally, the exam scores for the 45 first year Psychology participants were collected. The mean exam score for the 45 participants was 75% (range 53-93%). This was slightly higher than the class mean of 72% (range 39-98). No correlations were found between Psychology exam mark and the style ratios. However, when the exam scores were correlated with the eight ability tests, significant correlations were found with vocabulary tests scores (mean r = .44) and a significant correlation was found with the verbal factor ($\underline{r}$ = .425, $\underline{p}$ = .007). Unlike, Riding and Rayner (1998) the relationship between the style labels and performance on the Psychology 1 exam was not investigated due to the unstable nature of the style labels.

9.4 Discussion

The results of this study show that there were no consistent, significant correlations between the verbal-imagery dimension of the VICS, the wholistic-analytic dimension of the Extended CSA-WA and eight measures of ability and one measure of academic achievement. In addition, no ability measure correlated consistently and significantly with style or academic achievement over time. There were however, significant correlations between ability and each participant's raw reaction times to each of the style dimensions, but these associations did not extend to the style ratios.

Table 9.5
Table showing Pearson's correlations (p values) between the procedural/speed ability factor and the verbal ability factor with the median reactions times on each of the style dimensions of the VICS and the Extended CSA (E-CSA). Correlations in bold show the significant correlations between the two ability factors and the median reaction times.

	1	2	3	4	5	6	7	8	9
1 Procedural/Speed Ability Factor									
2 Verbal Ability Factor	.000 (1.000)								
3 VICS Verb Median RT S1	**-.293** **(.004)**	-.021 (.841)							
4 VICS Verbal Median RT S2	-.130 (.211)	.031 (.768)	.811 (.000)						
5 VICS Imagery Median RT S1	**-.334** **(.001)**	-.037 (.725)	.699 (.000)	.744 (.000)					
6 VICS Imagery Median RT S2	**-.328** **(.001)**	.016 (.881)	.600 (.000)	.733 (.000)	.831 (.000)				
7 E-CSA-Wholistic Median RT S1	**-.238** **(.021)**	.050 (.632)	.575 (.000)	.488 (.000)	.558 (.000)	.520 (.000)			
8 E-CSA-Wholistic Median RT S2	**-.326** **(.001)**	-.048 (.645)	.544 (.000)	.556 (.000)	.554 (.000)	.570 (.000)	.742 (.000)		
9 E-CSA Analytic Median RT S1	**-.312** **(.002)**	.006 (.957)	.577 (.000)	.461 (.000)	.510 (.000)	.440 (.000)	.719 (.000)	.582 (.000)	
10 E-CSA Analytic Median RT S2	**-.380** **(.000)**	-.053 (.612)	.545 (.000)	.508 (.000)	.541 (.000)	.564 (.000)	.557 (.000)	.754 (.000)	.687 (.000)

Overall, these results provide support for the independence of the verbal-imagery style ratio and wholistic-analytic style ratio (measured by the VICS and the Extended CSA-WA) from mental abilities and some evidence that it does not directly effect academic performance. This finding is important because it provides crucial evidence for the incremental validity of the VICS test and the Extended CSA-WA as style measures, which Furnham (1995) argues is lacking in many other tests of style.

Austin, Hofer, Deary and Eber (2000) note that while correlations provide useful information about the association between two measures, this method is prone to the generation of type 1 errors. The lack of consistent correlations between style and ability over time, in this study suggests that these significant correlations may have been type 1 errors. Furthermore, most of the correlations that were found between ability and style had no obvious explanation. For example, performance on the two imagery tasks (part 1 Paper Folding, part 1 and 2 Card Rotation) and one wholistic task (part 2 Gestalt Completion) all correlated with a session 2 verbal cognitive style. All of these ability tests were picture based and intended to measure other abilities and therefore the association with a verbal style may have been spurious. The only logical correlation between style and ability was between part 2 of the Extended Vocabulary test which correlated with a session 2 verbal style ($\underline{r} = .216$, $\underline{p} = .034$). This correlation however, did not appear with the other three verbal task sections and was only found to be significant when Pearson's correlations were used, therefore this correlation must also be called into question.

One limitation of the current study was that the ability level of participants was probably above average due to the sample consisting of university students. Riding and Agrell (1997) suggested that style might only be important when the ability level is low. Therefore, it is possible that no association between style, ability and academic performance was found because of the high mean ability of the sample. Evidence that the sample was performing above the norm can be seen in the ceiling effect which was reached for the mental rotation, paper folding and gestalt completion tasks[1]. These three tests were quite short and some participants managed to finish them within the allocated time and get all the answers correct. Despite the ceiling effects, there

[1] Note one item (a wagon) on part 1 of the gestalt completion task was answered incorrectly by all participants. When participants were told what the object was intended to be, they still failed to identify it. This suggests that the item was too difficult and may need to be reviewed.

was a broad range of scores on these tests which suggests that not all the participants found the three tests easy. Further evidence of participants' restricted ability level is the high exam scores of the 45 participants in Psychology 1. Future studies will need to investigate the relationship between style, ability and academic performance in participants with a broader range of abilities.

Arguably another potential limitation of this study is that there is no way of knowing whether the chosen ability tests were genuinely tapping into their intended ability (verbal, imagery, wholistic and analytic). Furthermore, the two tests allocated to each category may not have been measuring the same thing. The only exception to this was the verbal category, which was measured by two vocabulary tests identical in structure and layout. All the other ability categories were measured by two different tests. It does however, appear that the two tests within the verbal, imagery and analytic ability categories were broadly similar as participants' scores all correlated between .38 and .64. The two wholistic ability tests showed a low degree of association ($r = .12$), which suggests that the two tests chosen for this ability may need to be reviewed in future studies. Although there is no way of knowing exactly what the ability tests measure, it is important to remember that a good range of validated ability tests were used and no consistent, significant correlations with style were found.

The lack of significant correlations between the two extracted ability factors and the style ratios, but the presence of a significant correlation between the procedural ability factor and the median reaction times on each style dimension, suggest that it is the use of the ratio that removes the ability factor from the style measure. More specifically, this analysis has shown that while the ability factors correlate with the raw median reaction times on each style dimension, by creating a verbal-imagery ratio, between the verbal median reaction time and the imagery median reaction time, as well as a wholistic-analytic ratio, between the wholistic median reaction time and the analytic median reaction times, the ability factors no longer correlate with style. In other words, the use of the ratio appears to remove the ability factor from the VICS and Extended CSA-WA and thereby prevents a correlation between ability and style. This gives further evidence for the independence of the style ratio from ability and suggests that the use of a high ability sample may be less problematic than first thought.

In summary, this study investigated the relationship between ability, academic achievement and verbal-imagery and wholistic-analytic style (measured by the VICS and the Extended CSA-WA ratios). The results indicated that the verbal-imagery and wholistic-analytic style ratios are independent of the ability tests chosen and from performance on the University of Edinburgh Psychology 1 multiple-choice exam.

Therefore, the results from Chapters 8 and 9 suggest that cognitive style, as measured by the VICS and the Extended CSA-WA ratios, are measuring something that cannot be fully explained either by ability or personality. The next Chapter will examine the relationship between cognitive style and instructional preference and information processing style.

Chapter 10

Cognitive Style, Information Processing Style and Instructional Preference

10.1 Introduction

Previously, this thesis outlined the importance of establishing a cognitive style test's independence from ability and separation from personality. Another important criterion for establishing the validity of a new cognitive style measure is evidence that it is not measuring information processing style or instructional preference.

The difference between cognitive style, information processing style and instructional preference was made explicit by Curry in 1983. Curry proposed what is known as the Onion Model. The main aim of the model was to reduce the major learning style concepts and order them from the most fundamental, stable and central to the most peripheral, variable and changeable. The model was also an attempt to account for the differences in scope and predictive power across the many different style conceptualisations (Curry, 1987). The model Curry proposed consisted of three layers: Cognitive Personality Style, Information Processing Style and Instructional Preference.

Cognitive Personality Style was the innermost layer of the model and consequently it was thought to be the furthest from environmental influences and the least observable. Curry (1983) defined this layer as

> "the individual's approach to adapting and assimilating information, but this adaptation does not directly interact with the environment, rather it is an underlying, relatively permanent personality level dimension, that becomes manifest only indirectly by looking at universals within an individual's behaviour across many learning instances" (p.14).

The style examples Curry gave for this dimension included the Embedded Figures test (Witkin, 1962) and the Matching Familiar Figures Test (Kagan, 1965).

Information Processing Style was the second or middle layer. This layer was defined as "the individual's intellectual approach to assimilating information following the classical information processing model" (Curry, 1983, p.14). The examples given for this dimension included the Learning Style Inventory (Kolb, 1976) and the Inventory of Learning Processes (Schmeck, Ribich & Ramaniah, 1977).

Instructional Preference Layer was the outer layer. This layer was defined as "the individual's choice of environment in which to learn" (Curry, 1983, p.14). This layer was thought to be the most exposed to the environment and therefore easily modifiable by the person-environment interaction. Examples for this layer included the Learning Preference Inventory (Rezker & Rezmovic, 1981) and Grasha-Reichmann Student Learning Style Scales (Reichmann & Gasham, 1974).

Riding (1997) places the CSA's test of the wholistic-analytic and verbal-imagery style in the cognitive personality layer of Curry's model. The VICS test and the Extended CSA-WA test, which measure the same dimensions, can also be placed in this category. The cognitive personality layer seems appropriate for these tests because the dimensions they measure are thought to be relatively fixed "in-built features of the individual" (Riding & Cheema, 1991, p.196), they are relatively immune to environmental influences and they are measured by looking for consistencies in behaviour across a variety of trials.

In order to test whether the VICS and Extended CSA-WA are separate from the information processing layer and the instructional preference layer, it was necessary to compare participant performance on these tests with their performance on an information processing test and an instructional preference test.

In Curry's 1983 article, the examples given for the information processing and instructional preference layers (listed above) were some of the key style models in use at that time. Since then, many more measures have been designed and empirically tested. A recent citation analysis of the cognitive and learning styles literature by Desmedt and Vackle (2002) show that, to date, the researchers Kolb, Entwistle and Dunn and Dunn are ranked in the top three in terms of number of cited articles in the learning styles literature. These researchers have all designed there own style-like measure: Kolb (1976) designed the Learning Style Inventory (LSI); Entwistle and colleagues (Tait, Entwistle & McCune, 1998; Entwistle, Tait & McCune, 2000) designed what is currently known as the Approaches and Study Skills Inventory for Students (ASSIST); and Dunn, Dunn and Price (1979) also designed a test called the Learning Styles Inventory, but their inventory was built around the Dunn and Dunn (1979) learning styles model.

These three style models can be linked to Curry's (1983) Onion model. Curry specifically identified Kolb's LSI as belonging to the information processing layer and Dunn et al.'s LSI in the instructional preference layer (Curry, 1990b). The ASSIST was developed later and therefore its place in Curry's model was not defined. For the moment however, this thesis will argue that the ASSIST has roots in the information processing layer. Further justification for this distinction will be given later.

Unlike the ASSIST and the Learning-Styles Model, the psychometric properties of Kolb's LSI have been heavily criticised (e.g., Freedman & Stumpf, 1978; Wilson, 1986; Goldstein & Bokoros, 1992; Garner, 2000). Therefore the ASSIST, rather than Kolb's LSI, will be used in this study as a measure of information processing style. The development and details of the ASSIST and the adult version of Dunn et al.'s (1979) Learning Styles Inventory (Productivity Environmental Preference Survey [PEPS]) will be given below.

10.1.1 Approaches and Study Skills Inventory for Students (ASSIST)

The ASSIST has been developed over a number of years. It grew out of a general interest in the associations between students' motivation, study methods and their academic performance. As the measure evolved, it absorbed some of the current theories and constructs in the learning in higher education literature (Tait, Entwistle and McCune, 1998). Specifically, the ASSIST took concepts from the work of Marton and Saljo (1976) and combined them with the work of Entwistle and Ramsden (1983). Descriptions of these two key pieces of work are given below.

Marton and Saljo (1976) conducted a study in which they asked students to read an academic article about which they would later be asked questions. The questions they asked required students to give their understanding of the article and how they went about reading it. The students' descriptions of how they approached this task indicated differences in what was initially called "levels of information processing", with a direct reference to Craik and Lockhart's (1972) Level of Information Processing Model (Entwistle & McCune, 2002). More specifically, Marton and Saljo identified the 'deep' approach (reading for meaning) and the 'surface' approach (focusing on individual facts or words for reproducing). However, because the deep and surface categories contained both intention (intention to understand [deep] or intention to reproduce [surface]) as well as a processing component, it was decided that 'approaches to learning' would be a better description than 'levels of processing' (Entwistle & McCune).

The other line of research that contributed to the development of the ASSIST, was Entwistle and Ramsden's (1983) study which, unlike Marton and Saljo's (1976) study, focused more on study behaviour rather than the learning process. Entwistle and Ramsden interviewed students about their typical study habits and found that many of them were driven by an intention to achieve the highest possible grade, which they did by managing time effectively and by having organised study methods. This approach was identified as the strategic approach.

The predecessors to the ASSIST therefore combined the deep and surface approach taken from Marton and Saljo (1976) with the strategic approach from Entwistle and Ramsden (1983). The ASSIST itself also contains the three main scales labelled: deep, strategic and surface apathetic. However, it also included additional sub-scales to examine the individual's reactions to different teaching methods and it extended the description of studying to include metacognition and self-regulation sub-scales under the strategic approach and ineffective studying or 'lack of purpose' sub-scales under the surface approach (Entwistle et al., 2001). A description of each approach can be seen in Table 10.1 below.

Recently, Entwistle and McCune (in press) reviewed the conceptual bases of a variety of study strategy inventories and showed that several other measures, including Bigg's (1987) Study Process Questionnaire, Schmeck, Ribich and Ramanaiah's (1977) Inventory of Learning Processes, Entwistle and Ramsden's (1983) Approaches to Study Inventory, and Pintrich, Smith, Garcia and McKeachie's (1991) Motivated Strategies for Learning Questionnaire, contain variants of the same three underlying dimensions (deep, surface, strategic). These three factors were shown to emerge consistently despite some of the tests being derived from contrasting theoretical perspectives and developed for different purposes (Entwistle & McCune, in press). This suggests that the three approaches to studying are relatively robust factors.

The factor structure of the ASSIST was first investigated by Tait et al. (1998). Their study conducted factor analysis and internal reliability analysis on the ASSIST using a sample of 1231 mainly first year university students from six different institutions and a range of disciplines. Three factors were found which together explained 60% of the variance. The factors were then subjected to an oblique rotation. The Cronbach alpha's for the three main scales were found to range from .80 to .87 and the sub-scales ranged from .54 to.76 with a median of .62. Therefore all of the sub-scales exceed the minimum accepted value of .5.

Sadler-Smith (1997) suggested that, in terms of function and process, the ASI (an earlier version of the ASSIST) may lie between Curry's Cognitive Personality Layer and the Instructional Preference layer, but he seemed unwilling to place it directly into the middle information processing layer. The deep and surface process aspects of the ASSIST (and its earlier versions) have acknowledged connections with the information processing layer; however, the three main approaches are also argued to be context dependent and susceptible to change in the teaching-learning environment (Biggs, 1993, Marton & Sajlo, 1997). For example, Tait et al. (1998) note that a student's approach to learning might change just by completing the ASSIST questionnaire and reflecting on the issues raised. However, Entwistle (1999) argues that an approach contains elements of both consistency and variability. For example, when students are interviewed about their everyday studying, where there are multiple tasks and pressures, students often developed

Table 10.1

Defining features of the ASSIT adapted from Entwistle, McCune and Walker (2001).

Deep Approach	Seeking Meaning
Intention - to understand ideas for yourself By: Relating ideas to previous knowledge and experience Looking for patterns in underlying principles Checking evidence and relating it to conclusions Examining logic and argument cautiously and critically Being aware of understanding developing while learning	
Surface Apathetic Approach	**Reproducing**
Intention – to cope with course requirements By: Treating the course as unrelated bits of knowledge Memorising facts and carrying out procedures routinely Finding difficulty in making sense of new ideas Seeing little value or meaning in either courses or tasks set Studying without reflecting on either purpose or strategy Feeling undue pressure and worry about work	
Strategic Approach	**Reflective Organising**
Intention - to achieve the highest possible grade By: Putting consistent effort into studying Managing time and effort effectively Finding the right conditions and materials to study Monitoring the effectiveness of ways of studying Being alert to the assessment requirements and criteria Gearing work to the perceived preferences of lecturers	

routine strategies as ways of dealing with similar tasks and contexts. Consequently, Entwistle (1999) describes an approach to learning as "an individual difference, but one with a relatively low level of consistency, being markedly affected by both context and the content of the task set" (p.15).

In summary, to some extent it is perhaps misleading to place the ASSIST solely in the information processing layer, but it would be equally wrong to place it solely in the instructional preference layer. In any case it seems safe to say that the ASSIST is not a measure of cognitive personality style (like the VICS and the Extended CSA-WA) and it is likely to be closer to the Information Processing Layer than the Instructional Preference layer.

Overall, the ASSIST's popularity, internally robust structure and the fact that it is an information processing type measure, make it a suitable test with which to compare the VICS and the Extended CSA-WA test of cognitive style.

10.1.2 The Productivity Environmental Preference Survey (PEPS)

The PEPS was designed by Dunn, Dunn and Price in (1981) to be the adult version of their earlier Learning Styles Inventory (LSI) (Dunn, Dunn and Price, 1979). Research on these tests grew out of an interest in how students learn and specifically what elements encourage or inhibit learning (Rundle & Hankinson 2001). The theory underlying the test's development was that people have biologically based physical and environmental learning preferences that, together with emotional and sociological and psychological preferences, combine to give an individual a learning style profile (Murray-Harvey, 1994). Therefore, Dunn et al.'s learning style measures are based on a multi-dimensional model, rather than a bipolar model, as they encompass environmental, emotional, sociological, physical and psychological variables.

The stated purpose of the PEPS is to identify how adults prefer to function, learn, concentrate and perform in their occupational or educational activities (Price, 1996). It is predicted that productivity and learning will increase when preferences are matched with working conditions or instructional environments. The PEPS identifies 20 factors (called elements), which are grouped in to four categories: i) Immediate Environment (noise, temperature, light and design); ii) Emotionality (motivation, responsibility, persistence and structure); iii) Sociological Needs (peers, authority-oriented, or learning in several different ways); and iv) Physical Needs (auditory, visual, tactile, kinaesthetic, evening/morning, late morning, afternoon, intake and mobility) (Price, 1996). Further explanation of these categories is given in Table 10.2 below. There is also a fifth category in the Dunn and Dunn Model called Processing Inclinations (global/analytic, right-left and impulsive/reflective) but this is not directly measured in the PEPS inventory.

An individual's learning style is made up of the combination of the element in the model by which they are affected. Typically, individuals are affected by 6-14 of the possible 21 elements, in other words, not all elements will be important for all individuals (Dunn, 1983).

Like the ASSIST, the factor structure of the PEPS was also developed using factor analysis. Thirty-one factors were extracted using the eigenvalue greater than one criterion. Together these factors explained 65% of the variance. The factors were subjected to orthogonal rotation and the matrix converged in 50 iterations. Some of the identified factors that overlapped with other factors were combined, resulting in a revised instrument which contained 20 elements (Price, 1996). The internal reliabilities of the final 20 factors were tested using Cronbach alphas. Eighteen of the 20 factors had reliabilities equal or greater than .60. Authority – Oriented Learners and Tactile Preferences were lower (.48 and .33 respectively).

The Dunn and Dunn model of learning style was identified by Curry (1990b) as having a place in the information processing layer of style. Honigsfeld (2001) however, argues that the Learning Styles Inventory (LSI – the children's version of the PEPS) fits into both the Information Processing Layer and the Instructional Preference Layer, because the LSI contains a group of questions relating to processing inclinations (global-analytic etc.), as well as questions about environmental preferences. Curry (1990b) acknowledges this concern, but she believes that the bulk of the theory describes the features of the situation in which learning occurs and therefore it is more suited to the instructional preference layer (p.8). The processing inclinations element that Honigsfeld argues gives the LSI an information processing flavour, is not directly measured by the PEPS and therefore the placement of the PEPS in the instructional preference layer is even less contentious (Murray-Harvey, 1994).

Table 10.2
Features of the Dunn, Dunn and Price (1981) Productivity Environmental Preference Survey taken from Murray-Harvey (1994)

Style Area	Style Element	Preference for
Environmental	Noise Level	Sound vs quiet
	Light	Bright vs dim light
	Temperature	Warm vs cool environment
	Design	Informal (sofa, floor) vs formal (table, chair) seating arrangement
Emotional	Motivation	Desire to achieve
	Persistence	Engaging in tasks until completed or taking breaks
	Responsibility	Conforming to expectations
	Structure	Specific directions vs latitude
Sociological	Peers	Learning alone vs with others (pairs, groups)
	Authority	Directions from an expert
	Several ways	Variety of methodologies and or an ability to cope with the same
Physical	Auditory	Learning by listening or hearing
	Visual	Learning by watching or reading
	Tactile	Learning by hands-on e.g., note taking
	Kinaesthetic	Learning by active involvement (direct experience)
	Intake	Eating, drinking, to help concentration
	Evening/morning	Learning in the evening vs learning in the morning
	Late morning	Learning in the late morning
	Afternoon	Learning in the afternoon
	Mobility	Taking breaks vs able to sit still for long periods

Murray-Harvey (1994), suggests a different problem with placing the PEPS in the instructional preference layer. Murray-Harvey notes that the learning style preferences in the PEPS and LSI are thought to be "biological determined, resistant to change and stable over time" (Murray-Harvey, 1994, p.383). On face value, this places the Dunn and Dunn model closer to the cognitive personality layer which is thought to be stable, trait-like and less open to environmental influences. However, as Dunn and Dunn have carried out no test re-test reliability on the PEPS or the LSI, their claim to stability has not been empirically shown (Murray-Harvey). Furthermore, Murray-Harvey (1994) has found evidence to suggest that test re-test reliability on the PEPS over an eight week and a 12 month period was poor. In addition, some of the factors, that were argued to be biologically based, showed the lowest reliabilities (mean $\underline{r}$ = .39). Therefore, the PEPS's instability over time provides further evidence that it belongs in the outer, less stable layers of Curry's style model as opposed to the inner, more stable, cognitive personality layer.

10.1.3 Conclusion

Overall, the ASSIST and the PEPS are popular style measures that seek to give us an understanding of the differences in the way students learn. They also provide us with a framework for evaluating these individual differences with the aim of improving student learning outcomes. The ASSIST and PEPS appear to have reasonably good internal consistency and both are believed to help with the identification of students who are experiencing difficulty with their studies and also help identify how the teaching and learning environment influences student learning (Tait et al., 1998; Price, 1996).

In addition, evidence was discussed to support the suggestion that the ASSIST and PEPS appear to measure the outer two layers (information processing and instructional preference) of Curry's Onion Model of style. They therefore provide a potential contrast with the VICS and Extended CSA-WA style tests, which are argued to be measures of the inner cognitive personality layer of style. It is however, important to remember that the PEPS, ASSIST, VICS and Extended CSA-WA are all designed to measure different aspects of style. Therefore, evidence in support of a low association between the tests may not be because they represent different layers of Curry's

(1983) style model, but because either the tests are measuring different content or the tests are unreliable.

Despite this potential interpretation ambiguity, this study aims to investigate whether the VICS and the Extended CSA-WA are measuring something separate from the ASSIST and the PEPS and whether the cognitive personality layer is separate from the information processing and instructional preference layer of style.

10.2 Method

10.2.1 Participants

The same 100 hundred participants took part in the study as above (see Chapter 6, section 6.3.1 for details).

10.2.2 Apparatus

The VICS test and the Extended CSA-WA test were presented as above. The Approaches and Study Skills Inventory for Students (ASSIST) (Tait, Entwistle & McCune, 1998; Entwistle, Tait and McCune, 2000) and the Productivity Environmental Preference Survey (Dunn, Dunn & Price, 1996) were also administered.

The ASSIST is made up of 13 oblique sub-scales measured on a five point Likert scale. Each sub-scale contains four questions giving a total of 52 questions in the inventory. The deep, surface apathetic and strategic approaches are measured by three sub-scales each and the additional four sub-scales measure aspects related to the three main approaches. Specifically, the deep approach contains the sub-scales seeking meaning, relating ideas and use of evidence. The strategic approach contains the sub-scales organised study, time management and alertness to assessment demands. The surface apathetic approach contains the sub-scales, lack of purpose, unrelated memorising, and syllabus-boundness. The four related sub-scales are interest in ideas, achieving, monitoring effectiveness, and fear of failure (see Tait et al., 1998; and Entwistle, McCune and Walker, 2001 for more detail). Although the related sub-scales are associated with one of the three main approaches, their degree of association is thought to vary depending on the nature of the sample. See Table 10.1 for more details. An individual's score is calculated by adding together the responses on that sub-scale. Scores on the three approaches are calculated by adding together the sub-scales that make up each approach.

As stated above, the PEPS contains 20 elements measured on a five point Likert scale. Five questions make up each element giving a total of 100 questions. The elements measured are sound, light, warmth, formal design, motivation, persistence, responsibility, structure learning alone/peer-oriented, authority-oriented, learning in several different ways, auditory preference, visual preference, tactile preference, kinaesthetic preference, eveningness/morningness, late morning, afternoon, needs mobility and required intake (food) (see Table 10.2 for more details). The elements are argued to be largely orthogonal (Price, 1996) and an individual's score for each element is calculated by adding together the number of responses made on that element.

10.2.3 Design

This experiment was designed to compare each participant's cognitive style preference on the VICS and the Extended CSA-WA test (measured at two points in time) with their information processing style and instructional preference measured by the ASSIST and the PEPS.

10.2.4 Procedure

Participants were tested individually in a quiet room. At session 1, each participant completed the VICS test, followed by the ASSIST questionnaire and the Extended CSA-WA test. Details of the administration procedure of the VICS and the Extended CSA-WA are given above. The instructions for the ASSIST were written on the questionnaire and participants were asked to read the instructions carefully before answering the questions.

At session 2 participants were asked to complete the VICS for the second time, followed by the PEPS and then the Extended CSA-WA for a second time. The instructions for the PEPS were also written on the questionnaire.

10.3 Results

The results section is divided into two parts. The first part will outline associations between the ASSIST the VICS and the Extended CSA-WA. The second part will outline the associations between the PEPS the VICS and the Extended CSA-WA.

10.3.1 VICS, Extended CSA-WA and the ASSIST

Table 10.3 below gives the mean, median, minimum, maximum and standard deviations for participants' scores on each sub-scale and each approach measured by the ASSIST. The results suggest that in general there was a broad range of responses across the scales. In terms of the three main approaches (deep, surface and strategic), the majority of the sample indicated a tendency to be deep (mean = .45 range 24-60), followed by strategic (mean = 37.5, range 16-58) and lastly surface (mean = .33, range 18-55).

Correlations between the verbal-imagery and wholistic-analytic cognitive style ratio (measured by the VICS and the Extended CSA-WA) and the ASSIST can be seen in Tables 10.4 and 10.5 below. No significant correlations were found between the three approaches to studying and cognitive style (see Table 10.4). The first four columns of Table 10.5 show the relationships between cognitive style ratios at session 1 and 2 and the ASSIST sub-scales. No consistent correlations were found between the ASSIST sub-scales and style over time. Furthermore, no significant correlations were consistent between the Pearson's and Spearman's correlations coefficient tables (for the Spearman's rho table see Appendix 6). The inconsistent but significant correlations that were found between the ASSIST and style are given in bold in Table 10.5. Overall these low and inconsistent correlations explain no more than 7.3% of the cognitive style variance.

An analysis of the correlations between the sub-scales of the ASSIST show the sub-scales within each approach correlate significantly with each other (deep approach mean $r = .604$; strategic approach mean $r = .471$, surface approach mean $r = .258$). With the exception of the fear of failure sub-scale, all the related sub-scales correlated significantly with their intended approach. In addition, the sub-scales that made up the deep approach correlated negatively with the sub-scales that made up the surface approach (mean $r = -.40$), leading to an overall correlation of $r = -.555$ ($p < .001$) between the deep and surface apathetic approaches.

Table 10.3

Table showing the mean, median, minimum, maximum and standard deviations of the participants responses to the ASSIST sub-scales. The related sub-scales are given in brackets

	Mean	Median	Min	Max	Std Deviation
Deep Approach	43.41	45.0	24	60	7.89
Seeking meaning	14.47	15.0	7	20	2.93
Relating ideas	14.32	15.0	6	20	3.35
Use of evidence	14.62	15.0	8	20	2.91
(Interest in ideas)	14.82	15.0	6	20	3.36
Strategic Approach	37.67	37.5	16	58	8.64
Organised studying	12.47	13.0	4	20	3.63
Time management	10.86	11.0	4	19	3.87
Alert to assessment demands	14.34	14.5	5	20	3.12
(Achieving)	13.73	14.0	6	20	3.09
(Monitoring effectiveness)	14.34	15.0	5	20	3.12
Surface Apathetic Approach	33.00	33.0	18	55	6.76
Lack of purpose	8.80	8.5	4	19	2.97
Unrelated memorising	10.60	10.0	4	18	2.96
Syllabus bound	13.60	14.0	6	20	3.57
(Fear of failure)	12.87	12.0	4	20	3.87

Table 10.4

Pearson's correlations (p values) between the ASSIST's three approaches and VICS verbal-imagery cognitive style ratio and Extended CSA-Wholistic-Analytic cognitive style ratio. Correlations in bold were significant.

		1	2	3	4	5	6
1	VICS Verbal-Imagery Ratio S1						
2	VICS Verbal-Imagery Ratio S1	**.549** (**.000**)					
3	E-CSA-Wholistic-Analytic Ratio S1	.037 (.714)	-.085 (.400)				
4	E-CSA-Wholistic-Analytic Ratio S2	.024 (.811)	.094 (.353)	**.554** (**.000**)			
5	Deep Approach	.030 (.764)	.057 (.574)	.005 (.965)	-.010 (.918)		
6	Strategic Approach	.004 (.966)	-.089 (.379)	.174 (.083)	.117 (.246)	.166 (.097)	
7	Surface Approach	.002 (.985)	.020 (.843)	-.005 (.958)	-.010 (.918)	**-.555** (**.000**)	-.121 (.226)

Table 10.5

Pearson's correlations (p values) between the ASSIST sub-scales and VICS verbal-imagery ratio and Extended CSA Wholistic-Analytic ratio of cognitive style. Underlined correlations are significant. Correlations in bold show the correlations between the ASSIST and style.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1 VICS Verbal-Imagery ratio S1																
2 VICS Verbal-Imagery ratio S2	**.549 (.000)**															
3 E-Wholistic-Analytic S1	.037 (.714)	-.085 (.400)														
4 E-Wholistic-Analytic S2	.024 (.811)	.094 (.353)	**.554 (.000)**													
5 Seeking meaning	.036 (.721)	-.016 (.874)	.024 (.812)	-.035 (.727)												
6 Relating ideas	.045 (.660)	.123 (.222)	-.109 (.279)	-.087 (.389)	.583 (.000)											
7 Use of evidence	-.005 (.957)	.029 (.777)	.114 (.261)	.107 (.287)	.614 (.000)	.615 (.000)										
8 Interest in ideas	.000 (.998)	.015 (.885)	.152 (.132)	.055 (.585)	.302 (.002)	.515 (.000)	.491 (.000)									
9 Organised studying	.047 (.645)	-.018 (.861)	.080 (.431)	.087 (.388)	.207 (.038)	-.028 (.781)	.151 (.131)	.207 (.038)								
10 Time Management	.018 (.863)	-.035 (.727)	.185 (.065)	.113 (.263)	.254 (.010)	.019 (.848)	.101 (.316)	.159 (.1130	.749 (.000)							
11 Alert to assessmt demands	-.064 (.526)	-.182 (.070)	.161 (.110)	.082 (.415)	.175 (.080)	-.018 (.860)	.234 (.019)	.115 (.251)	.374 (.000)	.290 (.003)						
12 Achieving	-.091 (.370)	-.078 (.439)	.178 (.077)	.142 (.158)	.198 (.047)	.023 (.821)	.210 (.035)	.389 (.000)	.643 (.000)	.737 (.000)	.453 (.000)					
13 Monitoring effectiveness	-.067 (.506)	**-.225 (.024)**	.170 (.090)	.089 (.380)	.225 (.024)	.021 (.838)	.269 (.006)	.234 (.018)	.533 (.000)	.567 (.000)	.430 (.000)	.541 (.000)				
14 Lack of purpose	.064 (.525)	.124 (.217)	-.151 (.134)	-.133 (.188)	-.138 (.170)	-.195 (.050)	-.181 (.069)	-.434 (.000)	-.192 (.054)	-.159 (.111)	-.151 (.131)	-.362 (.000)	-.197 (.048)			
15 Unrelated memorising	-.011 (.911)	-.010 (.919)	.151 (.134)	.114 (.259)	-.386 (.000)	-.402 (.000)	-.430 (.000)	-.267 (.007)	.036 (.724)	-.015 (.879)	-.095 (.343)	-.082 (.414)	.031 (.757)	.259 (.009)		
16 Syllabus bound	-.041 (.689)	-.057 (.573)	-.010 (.924)	-.004 .(970)	-.366 (.000)	-.433 (.000)	-.465 (.000)	-.361 (.000)	-.092 (.358)	-.145 (.147)	.188 (.060)	-.231 (.020)	-.119 (.235)	.240 (.016)	.276 (.005)	
17 Fear of failure	-.132 (.192)	-.123 (.222)	.170 (.090)	.057 (.572)	-.176 (.079)	-.236 (.017)	-.086 (.391)	-.100 (.319)	.052 (.608)	-.006 (.955)	.123 (.220)	.048 (.632)	.210 (.035)	.019 (.847)	.431 (.000)	.148 (.139)

10.3.2 VICS, Extended CSA-WA and the PEPS

Table 10.6 below gives the mean, median, minimum, maximum and standard deviations for participants' scores on the 20 elements in the PEPS. The results are also in keeping with Price's (1996) random sample of 1000 subjects which found that typical scores ranged between 20-80, with a mean of 50 and a standard deviation of 10. The element structure had a slightly higher mean than expected ($M = 61.7$; $SD = 6.8$), which reflected a general preference in the sample for a structured working environment where clear goals and objectives are given.

Correlations between the verbal-imagery and wholistic-analytic cognitive style ratio (measured by the VICS and the Extended CSA-WA) and the PEPS can be seen in Table 10.7 below. The first four columns of Table 10.7 show the relationships between the cognitive style ratios at session 1 and 2 and all the PEPS elements. No consistent correlations were found between the PEPS and style over time. The inconsistent but significant correlations that were found between the PEPS and style are given in bold. Overall, theses low and inconsistent correlations explain no more than 6.5 % of the cognitive style variance.

An analysis of the correlations between the elements of the PEPS shows that several of the elements correlated with each other. Due to the increased chance of a type 1 error with this kind of analysis, only the correlations that were significant at $p < .01$ will be mentioned below. A preference for a formal working environment correlated negatively with preference for silence ($r = -.338$, $p = .001$). People who were well motivated also showed a preference to persevere with tasks ($r = .475$ $p < .001$). Those who liked structured tasks preferred a formal working environment ($r = .323$. $p = .001$). Individuals who liked responsibility also showed a preference for self motivation ($r = .534$, $p < .001$). Individuals who liked to learn under guidance of an authority figure also showed a preference for working with others ($r = -.468$, $p < .001$). A visual preference correlated negatively with auditory preference ($r = -.364$, $p < .001$). A preference for listening correlated with a tendency to be a less active learner ($r = .350$, $p < .001$). Finally, a preference for working in a variety of ways correlated negatively with working alone ($r = -.468$, $p < .001$), positively with working in a formal design environment ($r = .265$, $p = .007$) and positively with having a visual preference ($r = .290$, $p = .003$).

Table 10.6
Table showing the mean, median, minimum, maximum and standard deviations of the participants responses to the 20 element of the PEPS.

	Mean	Median	Min	Max	SD
Noise	51	50	41	62	5.59
Light	53	54	28	66	7.91
Temperature	51	50	34	76	9.38
Design	53	55	30	68	8.04
Motivation	47	47	26	60	7.11
Persistence	49	50	28	64	6.84
Responsibility	46	46	24	62	8.23
Structure	62	64	37	74	6.81
Alone/peers	49	47	32	76	8.91
Authority figure	54	55	34	76	8.51
Several ways	51	51	30	63	8.19
Auditory preferences	53	52	35	70	8.78
Visual preferences	50	50	29	65	7.75
Tactile preference	52	51	32	69	7.73
Kinaesthetic preferences	51	52	39	63	4.66
Kinaesthetic preferences	51	52	39	63	4.66
Requires intake	58	59	40	73	7.27
Requires intake	58	59	40	73	7.27
Time of day	47	47	27	63	8.55
Time of day	47	47	27	63	8.55
Late morning	50	50	30	75	9.90
Late morning	50	50	30	75	9.90
Afternoon	56	58	34	79	12.19
Afternoon	56	58	34	79	12.19
Needs mobility	54	55	39	69	6.78

Table 10.7

Pearson's correlations (p values) between the PEPS sub-scales and VICS Verbal-Imagery (VICS VI) ratio and Extended CSA Wholistic-Analytic ratio (E-CSA-WA) cognitive style. Underlined correlations are significant. Correlations in bold show the correlations between the PEPS and style.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	VICS VI ratio s1																	
2	VICS VI ratio s2	**.549 (.000)**																
3	E-CSA-WA ratio s1	.037 (.714)	-.085 (.400)															
4	E-CSA-WA ratio s2	.024 (.811)	.094 (.353)	**.554 (.000)**														
5	Noise	-.069 (.498)	-.079 (.433)	.065 (.518)	.086 (.392)													
6	Light	-.058 (.569)	-.014 (.890)	.148 (.141)	.172 (.086)	-.202 (.043)												
7	Temperature	-.065 (.521)	-.152 (.130)	**.282 (.005)**	.253 (.011)	.154 (.124)	-.045 (.658)											
8	Design	-.046 (.650)	.144 (.153)	-.006 (.953)	.074 (.464)	-.338 (.001)	.234 (.018)	.004 (.970)										
9	Motivation	-.072 (.476)	-.087 (.387)	**.249 (.012)**	.177 (.077)	.178 (.075)	.159 (.111)	-.016 (.876)	.120 (.233)									
10	Persistence	**-.248 (.013)**	-.096 (.342)	.093 (.357)	-.048 (.637)	.087 (.385)	-.100 (.319)	-.048 (.631)	-.028 (.781)	.475 (.000)								
11	Responsibility	-.072 (.476)	-.117 (.246)	-.026 (.798)	.142 (.158)	.115 (.253)	.052 (.609)	-.016 (.875)	.007 (.942)	.534 (.000)	.278 (.005)							
12	Structure	-.043 (.671)	.004 (.965)	.029 (.773)	.076 (.450)	-.285 (.004)	.036 (.720)	.050 (.621)	.323 (.001)	-.125 (.212)	.021 (.834)	-.221 (.026)						
13	Alone/peers	.135 (.180)	-.014 (.893)	-.093 (.356)	-.194 (.053)	.226 (.023)	-.170 (.089)	.342 (.000)	-.039 (.701)	-.189 (.058)	-.178 (.074)	-.147 (.141)	.048 (.634)					
14	Authority figure	.010 (.920)	-.030 (.769)	.082 (.415)	-.098 (.334)	.119 (.237)	.142 (.157)	.119 (.237)	.042 (.673)	.159 (.113)	.137 (.172)	.066 (.512)	.081 (.420)	.206 (.039)				
15	Several ways	.097 (.336)	.179 (.074)	-.070 (.488)	.097 (.338)	-.244 (.014)	.113 (.262)	-.243 (.014)	.265 (.007)	.217 (.030)	.240 (.016)	.122 (.224)	.214 (.031)	-.468 (.000)	-.009 (.927)			
16	Auditory	.065 (.518)	.068 (.500)	-.089 (.377)	-.080 (.426)	.028 (.782)	-.121 (.226)	-.044 (.665)	-.154 (.125)	.044 (.665)	-.091 (.365)	.056 (.579)	-.114 (.257)	.163 (.104)	.158 (.116)	-.058 (.565)		
17	Visual	-.003 (.978)	.019 (.848)	.090 (.372)	.069 (.495)	-.135 (.180)	.144 (.150)	.038 (.704)	.234 (.019)	.148 (.140)	.201 (.044)	.093 (.355)	.226 (.023)	-.235 (.018)	.050 (.623)	.290 (.003)	-.364 (.000)	

table continues

Table 10.7 continued

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
18	Tactile	.019	.022	.022	-.107	-.035	-.101	-.010	-.055	.125	.007	.030	-.014	.083	.026	-.001	.233	-.150
		(.853)	(.828)	(.831)	(.290)	(.725)	(.315)	(.917)	(.584)	(.215)	(.945)	(.768)	(.888)	(.409)	(.795)	(.994)	(.019)	.(136)
19	Kinaesthetic	-.149	-.010	.023	-.001	.033	.090	-.201	.070	.142	.072	.050	-.035	-.001	.270	.114	.350	-.149
		(.139)	(.920)	(.822)	(.990)	(.746)	(.372)	(.044)	(.484)	(.157)	(.474)	(.623)	(.731)	(.989)	(.006)	(.257)	(.000)	(.138)
20	Intake	-.124	-.183	-.202	-.114	.150	-.071	-.059	-.093	-.141	-.074	-.083	-.045	.175	.022	-.129	.061	-.139
		(.219)	(.068)	(.044)	(.258)	(.134)	(.478)	(.561)	(.354)	(.161)	(.461)	(.409)	(.658)	(.079)	(.829)	(.197)	(.541)	.169)
21	Time of day	.197	.185	.046	-.057	-.086	.178	.083	.058	.031	-.235	-.049	-.073	.230	.057	-.239	.047	-.207
		(.049)	(.066)	(.653)	(.576)	(.395)	(.075)	(.407)	(.567)	(.758)	(.018)	(.624)	(.470)	(.021)	(.573)	(.016)	(.641)	.039)
22	Late morning	.100	.025	-.058	-.105	-.128	.062	-.071	.151	-.049	-.230	-.058	-.029	.207	.154	-.044	.080	.-.156
		(.320)	(.804)	(.565)	(.300)	(.204)	(.543)	(.480)	(.135)	(.630)	(.022)	(.570)	(.772)	(.039)	(.126)	(.661)	(.430)	(.120)
23	Afternoon	-.105	.003	.105	.040	.140	-.165	.135	-.127	.029	.251	-.070	-.019	-.206	-.092	.102	-.031	.227
		(.299)	(.979)	(.298)	(.692)	(.166)	(.101)	(.182)	(.208)	(.777)	(.012)	(.489)	(.854)	(.039)	(.364)	(.312)	(.762)	(.023)
24	Mobility	-.105	-.163	.006	-.041	.146	-.052	.027	.183	.000	-.051	.007	-.078	.050	-.075	-.004	-.016	.032
		(.310)	(.111)	(.955)	(.691)	(.156)	(.613)	(.797)	(.075)	(.998)	(.625)	(.948)	(.448)	(.630)	(.468)	(.968)	(.877)	(.753)

Table 10.7 continued

		18	19	20	21	22	23
18	Tactile	-.156					
		.(118)					
19	Kinaesthetic	-.159	.170				
		(.113)	(.089)				
20	Intake	-.166	.191	.042			
		(.097)	(.056)	(.678)			
21	Time of day	-.215	-.048	.002	-.142		
		(.031)	(.636)	(.985)	(.157)		
22	Late morning	.066	.018	.148	.342		
		(.511)	(.862)	(.142)	(.001)		
23	Afternoon	.056	-.031	-.140	-.567	-.761	
		(.581)	(.761)	(.164)	(.000)	(.000)	
24	Mobility	-.035	-.062	.168	-.050	.124	.000
		(.736)	(.548)	(.102)	(.628)	(.229)	(.996)

10.4 Discussion

The results of this study show that there were no consistent correlations between the subjects' approaches to studying, their preferred learning environment and their cognitive style measured by the VICS and the Extended CSA-WA. More specifically, the sub-scales of the ASSIST and the elements of the PEPS all correlated at less than .26 with the verbal-imagery and wholistic-analytic cognitive style dimensions.

One interpretation of these results is that they provide support for the lack of association between the cognitive personality style layer (measured by the VICS and Extended CSA-WA) and the information processing and instructional preference style layers. This is potentially important because it suggests that the VICS and the Extended CSA-WA are not measuring the two outer style layers which gives credence to Curry's (1983) Onion Model of style and suggests that each layer may contribute something different to our understanding of style. One alternative interpretation of these results is that the VICS and the Extended CSA-WA did not correlate with the ASSIST and the PEPS because they were measuring different constructs. Distinguishing between these two options is impossible. Ideally, future research will be conducted using reliable style tests that are close in content to the VICS and the Extended CSA-WA, but that clearly measure the outer two layers of style. However, as discussed in Chapters 1 and 10, finding empirically tested and reliable style measures that fit clearly into a style layer is not a simple task.

Entwistle et al., (2001) note that another problem with correlational studies such as this is that they promote a view of student learning that implies a consistency in study behaviour that is often not found in reality. This is perhaps particularly so for information processing and instructional preference styles, which by Curry's definition are more easily influenced by the environmental context. Therefore, another interpretation of the lack of significant correlations between cognitive style and the ASSIST and PEPS is that the ASSIST and PEPS may be inherently less stable than the VICS and the Extended CSA-WA and this instability could underlie the low and insignificant correlations.

Regardless of the interpretation of these results, the lack of association between the ASSIST and the VICS verbal-imagery ratio and the Extended CSA-WA wholistic-analytic ratio was in keeping with the 1997 findings of Sadler-Smith. Sadler-Smith found no significant correlations between the verbal-imagery and wholistic-analytic style ratios of the CSA and participants' approaches to learning measured by the Revised Approaches to Study Inventory (an earlier version of the ASSIST).

In the current study, the correlations that were found between the VICS and Extended CSA-WA and the ASSIST and PEPS were low and inconsistent with cognitive style over time. This suggests that they may have been type 1 errors. The correlations that were found within the ASSIST and the PEPS were in keeping with their proposed factor structures (e.g., responses to the deep approach correlated etc.). The only exception to this was the negative correlation between the deep and the surface apathetic approach of the ASSIST ($r = -.555$, $p < .001$). The other associations were largely as expected and as they are not the focus of this study they will not be discussed further.

The negative correlation between the deep approach and surface apathetic approach to some extent suggests the existence of a continuum between these approaches. Entwistle and McCune (in press), note that "while there are negative correlations between factors describing the deep and surface approaches, these are typically quite low and there are distinct learning processes associated with each approach" (p.13).

Although the ASSIST and PEPS take a different approach to the assessment of learning style, at the item level both contain individual questions that, at face value, appear to be similar to the verbal-imagery and wholistic-analytic dimensions measured by the VICS and the Extended CSA-WA. Indeed, the ASSIST's deep approach is identified as containing element of Pask's (1976) constructs of holism and serialism (Tait et al., 1998). These concepts are similar to the wholistic-analytic constructs tested in this thesis (see Chapter 1 for more details). More specifically, the ASSIST's relating ideas sub-scale is identified as being associated with Pask's holist style and the use of evidence sub-scale is identified with Pask's serialist style. Similarly, the PEPS contains items which ask questions about verbal, auditory and imagery preferences which could be argued to have associations with the verbal-imagery dimension tested in this thesis. Despite the fact that the ASSIST and the PEPS contain questions which may relate to the wholistic-analytic and verbal-imagery dimensions, the factor structure of the ASSIST and PEPS means that these individual test items are subsumed within broader categories. Therefore, a correlational analysis does not highlight any significant correlations between potentially relevant items and style preferences. Unfortunately, the commercial nature of the PEPS means that the distributing company processes the data and the researcher is only given summative scores on a disk for each element. Consequently, it is difficult a priori to extract the responses to individual questions to see if the participant responses at the item level relate to their style preferences. It was possible to a priori extract items from the ASSIST that relate to the wholistic-analytic dimensions and examine participant responses to these items. The alpha coefficients however were found to be low ($r = .4$), making further analysis not possible.

In summary, this chapter has shown how four measures (the VICS, Extended CSA-WA, ASSIST and PEPS) relate conceptually to the three different layers of Curry's Onion Model of style (cognitive personality, information processing and instructional preference). The features of the three style layers are argued to differ in terms of permanence, predictive power and stability. The VICS test and the Extended CSA-WA test were argued to belong to the stable cognitive personality layer, the ASSIST was associated primarily with the information processing layer and the PEPS with the instructional preference layer. Having established these conceptual associations, the correlations between the VICS and the Extended CSA-WA styles and the information processing and instructional preference style were empirically examined. The main finding of this chapter was that the VICS and the Extended CSA-WA did not correlate consistently with the ASSIST or the PEPS. Whether this was due to the tests measuring different style layers, different content, or differences in the reliability of the tests, at present, remains unclear. In any case, to date there is no consistent evidence to suggest that the PEPS, ASSIST, VICS and Extended CSA-WA are psychometrically related.

Chapter 11

Instructional Preference, Behaviour and Cognitive Style

11.1 Introduction

Chapter 1 listed six criteria that Riding (1997) believes style measures need to meet in order to have construct validity. These are as follows: i) fulfil the criteria of a style; ii) the style dimensions should be independent of each other; iii) evidence of separation from intelligence; iv) independence from personality; v) related to observed behaviours; and vi) related to physiological measures (p.33). Chapters 5-8 have demonstrated that the VICS and the Extended CSA-WA meet the first four of these criteria. This aim of this chapter is to investigate whether the VICS and the Extended CSA-WA meet the fifth criterion, that is, whether cognitive style, measured by the VICS and the Extended CSA-WA, relates to observed behaviour.

In Riding's (1998) CSA Research Application guide, he states that "A very important aspect of the validity of style is that it should be related to observed behaviours. Further, these relationships should be large enough to have practical significance" (p.2). Riding (1991, 1998) argues that cognitive styles should relate to learning performance, learning preference, subject preference and social behaviour and they should have practical applications in terms of education and training, occupational guidance, career development, team building, counselling and personal development. Evidence that cognitive styles permeate our learning and behaviour and that they have practical applications is important if cognitive styles are to be seen as trait-like consistencies that should be measured and valued, rather than epiphenomena that may be dismissed or ignored.

Riding and colleagues have published numerous papers indicating that style preference on the CSA relates to a variety of observed behaviours and learning preferences. Chapter 1 outlined some of the relationships that have been proposed and therefore they will only be briefly mentioned here. Links have been made between the CSA's verbal-imagery and wholistic-analytic dimension and classroom behaviour (Riding & Craig; Riding & Burton, 1998), preferred learning (Riding & Douglas, 1993; Riding & Sadler Smith, 1992; Riding & Grimley, 1999), mode of presentation of material (Sadler-Smith & Riding, 1999;; Riding & Douglas, 1993; Riding & Watts 1997; Riding & Read, 1996) and with EEG activity in the brain (Riding et al., 1997; Glass & Riding, 1999). The extensive list of studies showing a relationship between verbal-imagery and wholistic-analytic style measured by the CSA and observed behaviour is quite impressive (see Riding & Rayner, 1998 for more examples) and it raises the question of how an unreliable test can obtain all these associations (Peterson et al., submitted).

One noticeable missing calculation in these studies is the effect size. For a practical measure, where accurate prediction is required, such as the CSA, the effect size is as important as the significance level. In other words, researchers should not only be concerned with whether or not the null hypothesis is false or not (i.e., the significance level) but also how false it is. If the difference between the alternative and null hypothesis is not zero, how large is it, and what is the minimal difference that is worth the researchers attention? (Yu, 2002). The lack of reported effect size for Riding colleagues' validity studies is an area worthy of further investigation.

Another problem with the validity studies is that many of these validity studies have used style categories rather than the style ratios to look for interactions and associations with behaviour. As noted in Chapter 3, the use of style categories rather than style ratios results in the CSA becoming even less reliable: the reliability falls below acceptable levels for a psychometric test. Therefore, the results of the studies that used the category measures (and particularly those that found associations between behaviour and the verbal-imagery dimension categories which has reliabilities close to zero) may need to be viewed with caution.

The problem with using style categories rather than ratios is exacerbated by the fact that Riding allows researchers to calculate the categories either using his norms (based on a standardised sample comprising 999 adults and children in the UK) or by dividing the sample into either two or three equally sized groups. The number of styles in each group would depend on whether the dimension was viewed as for example, verbaliser and imagers or alternatively as verbaliser, bimodals and imagers. The latter process of creating equal sized groups, assists with statistical analysis. One major problem with this process is that cut-off points for each style label (wholist, intermediate, analytic; verbal, bimodal, imagery) vary between the studies, making it difficult to make statements about wholists in general, if what is defined as a wholist can vary from study to study. This is perhaps acceptable if the researcher makes it clear that the findings are relative to their sample alone. However, the danger is that the findings are extrapolated to all wholists and that the test is sold to schools and businesses with claims (based on research) that a wholist is likely to perform in an X, Y, or Z way.

Table 11.1 shows the different style label cut-off points used in 11 studies that have employed the CSA. The table shows that verbal-imagery cut-off points are more consistent than the wholistic-analytic cut off points, but both vary. In one situation, a person with a wholistic-analytic ratio of 1.0 on the Riding and Read (1996) study would be classified as analytic, however, if the standardised norms (or several of the other studies cut-off points) had been used to create style categories or labels, that same person would have been classified as a wholistic. In another situation a person with a verbaliser-imagery ratio of 1.0 would be classified as an imager on the Riding et al., (1997) study, but would be classified as a verbaliser on the Riding and Agrell (1997) and the study. Differences as large as these make it increasingly difficult to make statements about the observed behaviour of one particular style group when the definition of the group can change between different studies.

Despite the problems with some of the current style and behavioural studies, this does not distract from the fact that it is important for a style measure to relate to observed behaviour. This thesis will focus on establishing whether the VICS and the Extended CSA-WA, which have been

Table 11.1

Table showing the cut-off points for the different style labels on the CSA taken by 11 different studies. The standardised norm cut-off points are given in italics. The items in bold show the lowest and highest value at each cut-off point.

Study	Verbal-Imagery dimension			Wholistic-Analytic dimension		
	Verbal	Bimodal	Imagery	Wholistic	Intermediate	Analytic
Riding & Agrell (1997)	**.35** - 1.05		1.06 – 3.93	.47 - 1.02		1.03 - 3.05
Riding & Watts (1997)	.69 - **.98**	**.99 - 1.09**	1.10 - 1.47	.63 - 1.03		1.04 - 2.11
Sadler-Smith & Riding	- 1.05		1.06 -	**- 1.19**		1.20 -
Riding et al. (1997)	**.93** - .99		**1.00** - 1.53	**.82** - .99		1.00 - **1.63**
Riding & Craig (1998)	.48 - 1.02	**1.03 – 1.15**	**1.16** - 8.21	.23 - .91	.92 - 1.15	1.16 - **4.11**
Riding & Read (1996)	.64 - **1.10**		1.11 - 1.50	.50 - .99		**1.00** - 1.85
Riding & Douglas (1993)	.63 - 1.01	1.01 – 1.14	1.15 - **1.47**	.54 - 1.08		1.08 - 1.92
Riding & Staley (1998)	.72 - .99	1.00 – 1.12	1.13 - 1.92	.42 - 1.06	**1.07 - 1.40**	**1.41** - 2.80
Riding & Wigley (1997)	.44 - .99	1.00 – 1.13	1.14 - 1.57	.31 - 1.00	1.01 - 1.38	1.39 - 3.49
Riding & Burton (1998)	.48 - 1.02	1.03 – 1.14	1.15 – **8.21**	**.23** - .89	.90 - **1.12**	1.13 - 3.52
Riding & Fairhurst (2001)				.50 - **.88**	**.89** - 1.12	1.13 – 3.06
Standardised Norms	*.00 - .98*	*.98 – 1.09*	*1.09 -*	*.00 – 1.02*	*1.02 – 1.35*	*1.35 -*

shown to be reliable measures of cognitive style, have associations with two observed behaviour measures that Riding and colleagues also used. However, rather than using style labels to look for associations between style and behaviour the style ratios will be used.

The first behavioural measure employed in this study was the Instructional Preference Inventory which was designed by Sadler-Smith and Riding (1999) for business studies students. Interest in the effects of differing instructional preferences has, in part, been stimulated by the increasing range of instructional methods and media now available to teachers and learners (Sadler-Smith & Riding, 1999). At the same time, a growing interest in the role of cognitive and learning styles led Sadler Smith and Riding to ask "how are styles and preferences related; do particular styles predispose individuals to particular preferences; and what effects do styles and preferences have on learning performance?" (p.355-356).

Sadler-Smith and Riding (1999) were also interested in using the CSA and the Instructional Preference Inventory to examine the different layers of Curry's (1983) Onion Model of style. They were interested in seeing whether the inner cognitive personality layer (which is argued to be measured by the CSA) related to the outer instructional preference layer (measured by the Instructional Preference Inventory). Two relationships were hypothesised. The first hypothesis was that the inner verbal-imagery dimension would interact with the outer preference for the mode of information presentation. For example, verbalisers were hypothesised to prefer text based information and imagers were not. The second hypothesis was that the inner wholistic-analytic dimension would interact with the outer preference for the structure and organisation of information. For example, analytics were expected to take a structured approach to studying and to prefer information set out in an organised way whereas, wholists were expected to need help in taking a structured approach. In other words, Sadler-Smith and Riding suggested that an individual's cognitive style on the verbal-imagery and wholistic-analytic dimensions was likely to result in preference for different types of instructional media, instructional method, and possibly also assessment methods.

Sadler-Smith and Riding's (1999) Instructional Preference Inventory was designed specifically for their study. The inventory was measured on a five point Likert scale and it had three sub-scales: instructional methods; instructional media; and assessment method (detail of the items in each sub-scale is given in section 11.2).

On completion of the data collection, Sadler-Smith and Riding (1999) factor analysed each of the sub-scales of the Instructional Preference Inventory and, with the selection criterion of eigenvalues greater than one, they identified factors within each of the three sub-scales. The sub-scale instructional methods resulted in three factors: collaborative methods (role play, discussion groups and business games); dependent methods (lectures, tutorials); and autonomous methods (flexible learning, and computer assisted learning). The instructional media sub-scales resulted in two factors: print based media (handouts, workbooks, textbooks, journal articles); and non-print based media (overhead transparencies, slides, videotapes). Finally, the assessment methods sub-scale resulted in two factors: formal assessment (examinations, tests, and essay questions); and informal assessment (individual assignments, group assignments, multiple-choice questions and short answer questions). These factors were compared with the participants' cognitive style category. The participants' cognitive style category was identified by dividing all the style ratios into two categories based on norms resulting in four separate categories of style (i.e., verbal, imagery, wholistic and analytic). Analysis of variance was then conducted using the identified instructional preference factors and the four different style categories.

The main findings were that wholists (as opposed to analytics) had a preference for collaborative methods which Sadler-Smith and Riding (1999) argued was in keeping with the more "gregarious and socially dependent wholists" (p.364). Wholists were also found to show a preference for non-print based media which was thought to be due to a their preference for an overall view. Finally, an interaction was found between style category, gender and a preference for informal assessment methods. The interaction indicated that, with the exception of the female verbaliser, the wholists showed a preference for informal assessment methods.

Overall, the findings of Sadler-Smith and Riding (1999) suggest that an individual's style on the wholistic-analytic dimension is related to their instructional preference and therefore style could be argued to have an impact on behaviour. Consequently, they also concluded that the cognitive personality layer of Curry's style model affects the instructional preference layer. Unfortunately, no correlations between the style ratios and the instructional preference factors were given (only the style category data was used and reported) and therefore, it is not clear what degree of overlap the Instructional Preference Inventory had with the more stable cognitive style ratios. In addition, the effect sizes were not reported and as noted above effect sizes are equally important as significance levels when it comes to accurate prediction. Nevertheless, the Instructional Preference Inventory seemed a suitable task to use in the current study with the VICS and the Extended CSA-WA.

The other task selected for this study was based on Riding and Watt's (1997) study. Unlike many other validity studies that used self-report measures of behaviour, Riding and Watts conducted a study that was designed to look directly at cognitive style and behavioural preferences. This study employed 90 female students aged 15-16 years. The students' cognitive styles were assessed on the CSA and then they were asked to come up to the front of the classroom one at a time to select one of three handouts on study skills. The handouts were structured in three different styles (unstructured, structured verbal and structured pictorial) but the verbal content remained identical. The unstructured handout was described as consisting of paragraphs without any headings. The structured verbal handout was described as consisting of paragraphs with clear headings, and the structured pictorial handout was described as containing paragraphs, each with a clear heading, and a pictorial icon in the left margin depicting the activity.

Like Sadler-Smith and Riding's (1999) study, the style ratios of participants were divided into groups for analysis. The wholistic-analytic ratios were divided into two categories (wholistic, analytic) and the verbal-imagery dimension ratios were divided into three categories (verbal, bimodal, imagery). The style labels were then compared with the choice of handout using a hierarchical log-linear analysis. The results found a significant interaction between verbal-imagery style and the handout format chosen, with the majority of verbalisers choosing the structured verbal handout and the imagers choosing the structured pictorial handout. No subjects chose the unstructured handout (see section 11.2 for more detail).

The Riding and Watts (1997) study suggested that an individual's style on the verbal-imagery dimension has an impact on their preferred format of instructional material. This study was therefore argued to provide behavioural evidence in support of the association between cognitive style measured by the CSA and observed behaviour. Unfortunately, this experimenter was unable to get a copy of the study skills sheets used in this study and therefore the descriptions of the handouts provided in the article were used as guidelines to design the feedback forms used in the current study.

In summary, this chapter outlines a study that was primarily conducted to test whether the VICS and Extended CSA-WA test of cognitive style related to two behavioural measures. The measure chosen were based on two studies, one by Sadler-Smith and Riding (1999) and one by Riding and Watts (1997). Both studies had previously found relationships between cognitive style measured by the CSA and observed behaviour and therefore an attempt to replicate these findings in the current sample using the CSA, VICS and the Extended CSA-WA was also made.

11.2 Method

11.2.1 Participants

The same 100 hundred participants took part in the study as described in section 6.3.1.

11.2.2 Apparatus

The VICS, Extended CSA-WA and the CSA tests were presented as outlined above.

Instructional Preference Survey

The Instructional Preference Inventory consisted of three sub-scales. Each sub-scale consisted of a list of seven items on which participants were asked to state their preference using a five point Likert scale (1 = strongly disagree, 5 = strongly agree). The three sub-scales and their items within each scale were as follows: i) instructional methods (lectures, tutorials, role plays, flexible learning, group work, computer assisted learning, learning through games); ii) instructional media (handouts, workbooks, textbooks, journals/articles, overhead transparencies, slides, video tapes; and iii) assessment method (examinations, group assignments, individual assignments, tests, essay questions, multiple-choice questions, short answer questions). The wording of two of the items from the original Instructional Preference Inventory were changed so as to be more relevant to psychology participants. Specifically, the item 'Business Games' was changed to 'learning through games', and 'open/distance/flexible learning' was changed to 'flexible (open) learning (CDs, video etc.)' after an email discussion with Sadler Smith as to what the item meant.

Handout Selection Task

In keeping with Riding and Watt's (1997) guidelines, three cognitive style handouts were prepared in different formats (structured verbal, structured pictorial and unstructured). The handout was modelled on Riding's (1991, 1998) Cognitive Styles Analysis Interpretation Sheet. It contained a definition of cognitive style, an outline of the different types of cognitive style, an explanation of how styles can affect learning and there was also a space on the handout for the experimenter to write in the identified cognitive style of the participant. The structured verbal form of this handout was formatted into paragraphs with clear headings. The structured pictorial handout consisted of paragraphs each with a clear heading and a relevant picture in the left margin. The unstructured handout consisted of paragraphs without headings (copies of the handouts can be found in Appendix 7). The text was kept the same in all three feedback sheets. The difference between them lay only in their format.

11.2.3 Design

This experiment was designed to compare each participant's cognitive style preference on the VICS, the Extended CSA-WA and the CSA test (measured at two points in time) with their instructional preference and their choice of feedback sheet.

11.2.4 Procedure

As stated above, participants were tested individually in a quiet room. At session 1, each participant completed the VICS, followed by the instructional preference test, the CSA and the Extended CSA-WA. For details of the cognitive style tests administration procedure see Chapter 3 section 3.6.1, and Chapter 5 section 5.2.5.

The instructions for the Instructional Preference Inventory were given on the questionnaire. Participants were asked "Based on your experience at school and university or any other education institute, please use the rating scales below to describe which methods of teaching, presenting and assessment you prefer." They were also asked to try and avoid selecting "no preference" unless they really didn't have a preferred option.

At session 2 participants were asked to complete the VICS, the CSA and the Extended CSA-WA for a second time and they were given the same task specific instructions as in session 1. At the end of session 2, the experimenter told the participant that the session was over and thanked them for taking part. They then asked the participants to "select one of the three feedback sheets" which were laid out on a table next to the subjects' £10 payment for participation and their receipt of payment. Once a feedback handout had been selected, the experimenter took it and filled in the blank space 'Your cognitive style is…..' using the participants' performance on the VICS and the Extended CSA-WA over two sessions as a guide. The handout was then given back to the participant to look over. The experimenter then explained to the participant what their cognitive style was and referred the participant to the relevant parts of the feedback sheet. Participants were given the opportunity to ask any questions about the study that they may have had from either session 1 or session 2.

11.3 Results

The result section is divided into two parts. The first part will examine the relationship between cognitive style and the Instructional Preference Inventory and the second part will examine the relationship between cognitive style and the type of handout selected.

11.3.1 Cognitive style and the Instructional Preference Inventory

Table 11.2 shows the mean, median, minimum, maximum and standard deviations for the responses to the Instructional Preference Inventory. The table shows that, while the full range of preferences from strongly disagree (1) to strongly agree (5) were used for most of the items, the majority of the responses were in the positive direction. The most variable responding seemed to be on the preference for assessment methods.

Correlations between the individual's instructional preference and their cognitive style ratios on the VICS and the Extended CSA-WA can be found in Table 11.3. Only two out of 52 correlations between style and instructional preference were significant. The first significant correlation was between a preference for being assessed with class tests (as opposed to assignments or essays) and a verbal style at session 1 ($r = .219$, $p = .029$). This correlation was

Table 11.2
Table showing the mean, median, minimum, maximum and standard deviations (SD) of the participants' responses to the items on the Instructional Preference Questionnaire.

	Mean	Median	Min	Max	SD
Instructional Material					
Lecture	3.5	4	2	5	.93
Tutorial	4.0	4	2	5	.95
Role play	2.5	2	1	5	1.14
Flexible learning	3.5	4	1	5	1.08
Group work	3.4	4	1	5	1.05
Computer work	3.1	3	1	5	1.00
Games	3.5	4	1	5	.99
Total	23.8	24	18	33	3.12
Instructional Media					
Handouts	4.0	4	1	5	.93
Work books	4.0	4	2	5	.82
Textbooks	3.8	4	1	5	.98
Journals/Articles	3.4	4	1	5	1.18
Overhead transparency	3.6	4	1	5	.98
Slides	3.4	4	1	5	1.05
Video tapes	3.7	4	1	5	1.02
Total	26.0	25	16	35	3.55
Assessment Method					
Exams	2.7	2	1	5	1.24
Group assignments	3.1	3	1	5	1.14
Individual assignment	3.8	4	1	5	1.03
Tests	3.1	3	1	5	1.07
Essay question	3.0	3	1	5	1.29
Essay question	3.0	3	1	5	1.29
Multiple Choice Questions	3.7	4	1	5	1.00
Multiple Choice Questions	3.7	4	1	5	1.00
Short answer questions	3.9	4	2	5	.86
Short answer questions	3.9	4	2	5	.86
Total	23.6	23	18	33	2.57
Total	23.6	23	18	33	2.57

Table 11.3
Correlations (p values) between cognitive style on the VICS verbal-imagery ratio (VICS-VI) and the Extended CSA-WA (E-CSA-WA) ratio and the items in the Instructional Preference Inventory. Correlations in bold are significant at p <.05.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 VICS VI S1																				
2 VICS VI S2	**.549 (.000)**																			
3 E-CSA-WA S1	.037 (.714)	-.085 (.400)																		
4 E-CSA-WA S2	.024 (.811)	.094 (.353)	**.554 (.000)**																	
5 Lecture	.014 (.893)	.141 (.161)	-.053 (.604)	.121 (.230)																
6 Tutorial	-.091 (.370)	.070 (.491)	-.160 (.111)	.024 (.809)	-.052 (.609)															
7 Role play	.042 (.680)	-.042 (.679)	-.013 (.902)	-.056 (.580)	-.166 (.099)	.060 (.553)														
8 Flexible learning	.072 (.475)	.109 (.282)	-.036 (.724)	-.080 (.430)	.023 (.819)	-.102 (.313)	.171 (.089)													
9 Group work	-.074 (.463)	.038 (.710)	.008 (.940)	-.034 (.735)	-.224 (.025)	.164 (.102)	**.280 (.005)**	-.048 (.635)												
10 Computer learning	.094 (.357)	.157 (.120)	-.044 (.665)	.048 (.637)	.030 (.765)	-.053 (.601)	.035 (.731)	**.241 (.016)**	.002 (.984)											
11 Games	.065 (.519)	.034 (.737)	.182 (.069)	.033 (.747)	-.031 (.763)	**-.281 (.005)**	**.413 (.000)**	**.264 (.008)**	.106 (.293)	.098 (.333										
14 Handouts	-.159 (.115)	-.118 (.242)	-.086 (.397)	-.039 (.703)	.165 (.102)	-.057 (.573)	-.207 (.039)	-.031 (.758)	.102 (.311)	.098 (.335	-.137 (.173)									
13 Workbooks	-.128 (.205)	-.085 (.400)	-.036 (.721)	.032 (.749)	-.133 (.187)	.025 (.804)	-.085 (.398)	-.225 (.025)	.092 (.361)	.011 (.917	-.027 (.792)	.167 (.098)								
14 Textbooks	-.035 (.726)	-.038 (.706)	-.045 (.654)	-.036 (.725)	**.247 (.013)**	-.009 (.929)	-.063 (.533)	.031 (.756)	-.108 (.283)	.046 (.652	-.109 (.280)	**.233 (.020)**	**.302 (.002)**							
15 Journals	.002 (.987)	-.067 (.509)	.092 (.363)	.175 (.082)	.125 (.216)	.050 (.624)	-.086 (.395)	-.042 (.677)	-.025 (.807)	.106 (.298	-.183 (.068)	.178 (.077)	.187 (.063)	**.425 (.000)**						
16 Transparencies	-.054 (.597)	.015 (.886)	-.143 (.157)	-.071 (.484)	**.238 (.018)**	-.039 (.699)	.060 (.552)	.035 (.729)	.086 (.400)	-.035 (.732	.088 (.385)	.138 (.174)	.021 (.834)	.119 (.239)	.101 (.318)					
17 Slides	.090 (.373)	.161 (.109)	-.128 (.204)	-.038 (.708)	.101 (.319)	.126 (.213)	**.289 (.003)**	.129 (.200)	**.207 (.039)**	.119 (.241	.152 (.131)	.089 (.379)	.025 (.804)	.113 (.264)	.068 (.503)	**.505 (.000)**				

table continues

Table 11.3 continued

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18	Videotapes	.016	-.136	-.058	-.116	-.077	-.038	**.335**	**.384**	.108	.193	**.253**	-.079	**-.218**	-.078	-.034	.134	**.347**			
		(.875)	(.177)	(.565)	(.249)	(.448)	(.708)	**(.001)**	**(.000)**	(.283)	(.056)	**(.011)**	(.433)	**(.029)**	(.441)	(.737)	(.185)	**(.000)**			
19	Exams	.133	.152	.093	.182	.142	.019	.007	.004	-.132	-.116	-.095	-.112	-.112	.040	.008	.196	.013	-.125		
		(.188)	(.131)	(.358)	(.070)	(.158)	(.850)	(.944)	(.969	(.189)	(.252)	(.347)	(.269)	(.265)	(.693)	(.936)	(.052)	(.900)	(.217)		
20	Group wk	-.065	-.036	-.072	**-.211**	-.018	.174	.124	-.091	**.469**	.004	-.044	.219	.126	-.031	-.085	.002	.133	.112	**-.287**	
		(.518)	(.725)	(.478)	**(.035)**	(.859)	(.083)	(.219)	(.367)	**(.000)**	(.969)	(.667)	(.029)	(.212)	(.762)	(.403)	(.982)	(.186)	(.269)	**(.004)**	
21	Individ wk	-.045	.016	.017	.086	**.233**	**-.223**	.021	-.010	-.090	.154	-.086	.130	.016	**.339**	.167	.073	.100	-.073	-.118	-.112
		(.657)	(.876)	(.867)	(.398)	**(.020)**	**(.026)**	(.832)	(.921)	(.375)	(.127)	(.393)	(.196)	(.872)	**(.001)**	(.097)	(.473)	(.322)	(.469)	(.244)	(.266)
22	Tests	**.219**	.190	.101	.059	.052	.204	-.021	.174	-.074	.029	-.187	-.052	-.105	.109	.155	.154	.096	-.014	**.429**	-.095
		(.029)	(.058)	(.316)	(.562)	(.609)	(.042)	(.839)	(.083)	(.464)	(.779)	(.062)	(.608)	(.297)	(.281)	(.123)	(.129)	(.340)	(.893)	**(.000)**	(.350)
23	Essays	-.061	.044	-.087	-.048	.044	.024	-.068	-.102	.030	.065	-.076	-.030	**.291**	**.384**	**.308**	.114	.124	.026	-.106	-.081
		(.549)	(.662)	(.388)	(.632	(.662)	(.814)	(.498)	(.313)	(.766)	(.524)	(.451)	(.765)	**(.003)**	**(.000)**	**(.002)**	(.262)	(.220)	(.799)	(.293)	(.424)
24	MCQ	-035	-.098	-.092	-.106	.011	.002	.106	**.273**	-.059	.163	.050	.051	-.116	-.088	-.269	-.039	-.057	**.337**	-.071	-.025
		(.730)	(.331)	(.363)	(.295)	(.917)	(.982)	(.293)	**(.006)**	(.558)	(.106)	(.618)	(.613)	(.249)	(.386)	(.007)	(.701)	(.572)	**(.001)**	(.484)	(.807)
25	Short Ans	.002	-.062	-.098	-.050	.183	-.097	-.133	.055	**-.222**	-.095	-.041	.081	**-.196**	.120	-.133	.070	-.073	.025	.042	-.107
		(.982)	(.539)	(.333)	(.620)	(.069)	(.337)	(.186)	(.586)	**(.027)**	(.350)	(.688)	(.424)	**(.050)**	(.235)	(.188)	(.489)	(.473)	(.805)	(.680)	(.291)

Table 11.3 continued

		21	22	23	24
22	Tests	.026			
		(.798)			
23	Essays	.163	**-.270**		
		(.105)	**(.007)**	.	
24	MCQ	-.060	.143	**-.299**	
		(.550)	(.155)	**(.003)**	.
25	Short Ans	.123	.032	-.168	**.265**
		(.222)	(.755)	(.095)	**(.008)**

also almost significant at session 2 ($r = .190$, $p = .058$). The second significant correlation was between a dislike for group work and being a wholist at session 2 ($r = -.211$, $p = .035$). These correlations are however, small, not consistent across sessions and they only explain 4.8 % of the variance.

Correlations between Riding's (1991, 1998) CSA's verbal-imagery and wholistic-analytic styles and the instructional preference can be found in Table 11.4. No significant correlations were found between the CSA's wholistic-analytic dimension and instructional preference. However, several significant correlations were found between the CSA's verbal-imagery dimension and cognitive style, but none of these correlations were significant at both session 1 and session 2. The lack of consistency across session 1 and session 2 style is not surprising given that the CSA's verbal-imagery session 1 and 2 ratio is not reliable ($r = .085$, $p = .4$).

As noted above the creation of style categories or labels lowers the reliability of the style measure therefore, the analysis of variance on different categories of style conducted by Sadler-Smith and Riding (1997) was not carried out on the current data.

In keeping with Sadler-Smith and Riding (1997), factor analysis of the Instructional Preference Inventory was conducted on each of the sub-inventories. The items in the instructional methods sub-scale were subject to a principal components analysis. Examination of the scree slope confirmed the existence of two factors which together explained 46 % of the variance. These factors were subjected to orthogonal (varimax) rotation. The resultant factor structure gave two categories of instructional methods. The first factor appears to be similar to Sadler-Smith and Riding's (1997) autonomous methods factor (open learning, games, computer-assisted learning, and role-play), although, the appearance of role play does not entirely fit with this category. The second factor appeared to be a group work factor consisting of tutorials, group work and a dislike of lectures.

The instructional media preference was also subjected to a principal components analysis. The scree slope produced two factors, which together explained 51 % of the variance. These factors were subjected to orthogonal rotation and the resulting factor structure gave two categories exactly the same as Sadler Smith and Riding's (1997) categories. In keeping with Sadler-Smith and Riding, these factors were called print (handouts, workbooks, textbooks and journal articles) and non-print (overhead transparencies, slides and videotapes).

Table 11.4
Table showing the correlations (p values) between the items on the Instructional Preference Inventory and the CSA's verbal-imagery (VI) and wholistic-analytic (WA) style ratios at sessions 1 and 2.

Instructional Preference Inventory	CSA VI Session 1		CSA VI Session 2		CSA WA Session 1		CSA WA Session 1	
Lecture	0.187	(.062)	-0.07	(.486)	0.013	(.899)	0.144	(.153)
Tutorial	0.044	(.661)	-0.056	(.578)	-0.085	(.403)	0.02	(.844)
Role-play	0.227	(.023)	0.167	(.097)	-0.095	(.347)	0.007	(.944)
Flexible learning	-0.049	(.631)	0.275	(.006)	-0.02	(.841)	-0.026	(.794)
Group work	-0.023	(.818)	0.055	(.587)	-0.005	(.957)	-0.089	(.379)
Computer learning	0.011	(.916)	-0.147	(.146)	-0.035	(.728)	-0.009	(.928)
Games	0.035	(.732)	0.019	(.849)	0.129	(.201)	0.055	(.589)
Handouts	-0.011	(.912)	0.078	(.440)	-0.061	(.544)	-0.106	(.296)
Workbooks	-0.018	(.861)	-0.066	(.514)	-0.125	(.214)	-0.019	(.853)
Textbooks	0.207	(.039)	0.167	(.096)	-0.03	(.765)	0.03	(.771)
Journal articles	0.177	(.079)	-0.054	(.592)	0.034	(.735)	0.143	(.154)
Overheads	0.233	(.021)	-0.119	(.241)	-0.132	(.193)	-0.07	(.488)
Slides	0.192	(.056)	-0.018	(.856)	-0.146	(.147)	-0.021	(.839)
Videotapes	-0.01	(.925)	0.223	(.026)	-0.025	(.804)	-0.053	(.599)
Exams	0.092	(.360)	-0.129	(.202)	0.019	(.847)	0.141	(.163)
Group assignments	0.035	(.727)	0.019	(.854)	-0.084	(.406)	-0.145	(.150)
Individual assignment	0.103	(.308)	0.042	(.677)	-0.004	(.967)	0.008	(.939)
Tests	0.001	(.992)	-0.064	(.528)	0.098	(.331)	0.125	(.214)
Essay questions	0.145	(.150)	0.026	(.794)	-0.068	(.503)	-0.098	(.334)
Multiple choice questions	0.008	(.935)	0.206	(.040)	0.003	(.975)	-0.092	(.361)
Short answer questions	0.113	(.265)	0.142	(.159)	-0.026	(.801)	-0.055	(.588)

Finally, the assessment method sub-scale was also subjected to principal components analysis. Examination of the scree slope resulted in three factors, which together explained 62% of the variance. These factors were orthogonally rotated and the resulting factor structure gave three categories: formal assessment (exams and tests); informal assessment (multiple choice questions, short answer questions and a dislike of essays) and group work (group assignments and a negative attitude towards individual assignments).

The extracted factors from each of the Instructional preference sub-scales were then correlated with the VICS and Extended CSA-WA session 1 and 2 ratios and the CSA verbal-imagery and wholistic-analytic session 1 and 2 ratios. The only significant correlations found were not consistent with the style ratios at both sessions 1 and 2. More specifically, a verbal preference on the CSA at session 1 correlated with a preference for non-print based media ($\underline{r}$ = .199, $\underline{p}$ = .049), a wholist preference on the CSA at session 2 correlated with a formal assessment method ($\underline{r}$ = .20, $\underline{p}$ =.046) and a verbal preference on the VICS at session 1 correlated with a preference for formal assessment methods ($\underline{r}$ = .26, $\underline{p}$ = .04).

11.3.2 Cognitive style and selected handout

The feedback sheet chosen was recorded for 70% of the participants. Twenty-four participants selected the structured verbal handout, 39 selected the structured-pictorial handout, and 7 selected the unstructured handout. Most participants did not spend long looking at the three handouts and many seemed to take the first one they saw. Using the Kruskal Wallice Differences Test, no main effects on the VICS and Extended CSA-WA style ratios were found for the selected handout (VICS Session 1 = W(2) = 1.73, $\underline{p}$ = .42; VICS session 2 = W(2) = .04, $\underline{p}$ = .98; Extended CSA-WA Session 1 = W(2) = 1.74, $\underline{p}$ = .42; Extended CSA-WA Session 2 = W(2) = 4.15, $\underline{p}$ = .136). One main effect was found between handout selected and a verbal-imagery style on the CSA at session 2 (W [2] = 7.75, $\underline{p}$ = .02) whereby those with a verbal style were more likely to select a verbal or an unstructured handout, but this effect was not found for the verbal-imagery style at session 1 (W [2] = 1.2, p = .94). No main effects were found for the CSA's wholistic-analytic dimensions (CSA Wholistic-Analytic Session 1 = W(2) = 2.40, p =.30; CSA Wholistic-Analytic Session 2 = W (2) = 4.38, p = .11) . Unlike, Riding and Watts' (1997) study a hierarchical log linear analysis was not conducted due to the problems associated with creating style labels mentioned above.

11.4 Discussion

This study found no consistent relationships between the VICS, the Extended CSA-WA and the CSA style ratios and performance on the Instructional Preference Inventory and no consistent relationship between style and the participant's preference for a particular feedback sheet. Although these relationships were not expected, it is possible that the lack of association may have been due to experimental design problems with the Instructional Preference Inventory and procedural problems with the handout selection task.

11.4.1 Instructional Preference Inventory

The intended audience of the original Instructional Preference Inventory differed between the original Sadler-Smith and Riding (1997) study and the present study. The original inventory was designed specifically for Business Studies students. The questionnaire was described as 'effectively a list of the methods they (the Business Studies students) have been exposed to at some stage' (p.363). In contrast, the participants in the current study were mostly Psychology students and it is possible that several of the items in the inventory were not familiar to them (e.g., role plays, workbooks, games, flexible open learning etc.). The results also indicated a tendency towards showing a positive preference for most of the items on the inventory with most participants claiming a "preference" or a "strong preference" for each item. This finding suggests that the Instructional Preference Inventory might not have been effective at eliciting a range of preference distinctions in the current sample.

In addition, there was a considerable age difference between Sadler-Smith and Riding's (1997) study and the present study. The mean age of participants in the original study was 24 years whereas the mean age in the current study was 20 years. Furthermore, 46% of participants in the current study were first year Psychology students. Therefore, the overall younger sample in this study and the high number of first year Psychology students probably resulted in participants making judgements on instructional methods with less prior experience. In particular, their experience of the instructional methods sub-scale items, which included lectures, tutorials, role plays, flexible or open learning, computer assisted learning or games, may have been limited.

Although, the Instructional Preference Inventory did ask participants to draw on experiences from school, university and any other educational institution they had been to, it is likely that those accumulated experiences were different from the older business study students in Sadler-Smith and Riding's (1997) sample.

These design problems are also, in part, reflected in the results of the principal components analysis of the Instructional Preference sub-inventories. In particular, the items in the instructional methods inventory (which the first year participants would have had less exposure to), when subjected to principal component analysis, resulted in factors that were quite different to that of Sadler-Smith and Riding (1997). Specifically, the current study elicited two factors, loosely named autonomous methods and group methods, whereas the original study resulted in three factors namely, collaborative methods, dependent methods and autonomous methods. In contrast, the instructional media and assessment methods, to which the current sample is more likely to have been exposed at school, were broadly similar. More specifically, the instructional media inventory (with factors print and non-print) mirrored Sadler-Smith and Riding's study exactly. Also, the assessment methods factors were similar, in that both extracted a formal and an informal methods factor, but a third factor (assignment method) was also added.

Although similar factors to Sadler-Smith and Riding (1997) were extracted from two of the Instructional Preference sub-inventories, no consistent correlations were found between the style ratios from the VICS, Extended CSA-WA and the CSA and the extracted factors. Sadler Smith and Riding's study did not correlate the CSA style ratios with the factors that they extracted, so it is not possible to directly compare the findings of the two studies. However, this study was able to compare both the CSA ratios and the VICS and the Extended CSA-WA ratios to the factors extracted and no significant consistent relationships were found, suggesting that neither the CSA nor the VICS and Extended CSA-WA have associations with instructional preference behaviour.

11.4.2 Choice of feedback sheet

The results on the choice of feedback sheet study were also negative. However, like the results of the Instructional Preference Inventory, there are several plausible explanations for the lack of association between participant style on the VICS, Extended CSA-WA and the CSA and feedback sheet preference.

The first problem was that the selection of the handout was done at the end of the second 90-minute session after the participants had been told that the experiment proper had finished. The three handouts were placed on a desk and participants were asked to select one feedback handout before leaving. Many participants were eager to get away and therefore just took the first handout on the table that they saw and they often showed little interest in the verbal feedback from the experimenter which was offered in addition to the information on the handout. The fact that seven students in the current study took the uninteresting unstructured verbal form (whereas none of the students in the Riding and Watts (1997) study took it) further indicates that there may have been several participants who did not consider the options before selecting a handout.

Another difference between Riding and Watts' (1997) task and the current study was that Riding and Watts asked the students to come up, one by one and select a handout. This made the task more of an event and therefore encouraged the students to consider more carefully which handout they preferred. In the current study the handouts were placed on a table in the room and the participants were asked to choose one of the three handouts while the experimenter sorted out the participant's payment for completing the two 90 minute sessions. This made the task of selecting a handout seem unimportant and as result the responding was less likely to be a considered choice. These procedural problems may have caused the lack of association between handout preference and style on the VICS, Extended CSA-WA and the CSA.

In conclusion, the Instructional Preference Inventory and the handout selection task, which were argued to be behavioural tasks, did not correlate consistently with any of the cognitive style ratios. The fact that no consistent relationships were found with the CSA style ratios, as well as the VICS and the Extended CSA-WA ratios suggests either that the experimental situations differed between the current study and the original studies (Sadler-Smith & Riding, 1997; Riding &Watts, 1997) or that the findings of the original studies need to be reviewed. It would be interesting to take the more stable style ratios in the earlier studies to see if behavioural relationships were present at this more reliable level of measurement. This would also allow a more direct comparison between the two studies to be made. However, as the reliability of the CSA has been questioned, any significant relationships found with the CSA, particularly with the CSA's verbal-imagery dimension which appears to be particularly unreliable, needs to be viewed with caution (Peterson et al., in press; chapter 2, chapter 5, and Parkinson & Redmond, 2002).

Overall, failure to find evidence that cognitive style related to observed behaviour (which is Riding's fifth criterion for the validity of cognitive style), although disappointing, does not mean the tests are a failure. As stated above, there were several design and procedural problems with this study and therefore, more research that is specifically designed to examine behavioural correlates with the VICS and the Extended CSA-WA (rather than being attached to the end of a larger study) needs to be conducted.

One place where behavioural correlates with style are likely to be found is in an individual's approach to different reasoning task (see for example Stenning, Cox & Oberlander, 1995). Associations between reasoning strategies and style has already been investigated to some extent by Pask and Scott (1972) with their 'Martian Animal Classification Task' however this task involves only one problem and it is not easy to administer, as a result there has been relatively little research conducted on it. The advantages of using reasoning tasks is that there are many different types of tasks that can be used (deductive, inductive, conditional syllogisms, categorical syllogisms etc.) and the problems can be presented in either a graphical or a linguistic form. This combination enables researchers to construct a variety of problems that are designed to be biased towards individuals with a particular style. For example, analytical questions can be designed that often require the use of a diagram and involve working within constraints, or more wholistic problems can be designed that involve thinking outside the square and focusing on the broader concepts (Monaghan, 2000). Using tasks of this nature it may be possible to compare an individual's cognitive style with their level of abstraction on different reasoning tasks and see how easy people with different styles find different reasoning problems.

Another way of investigating behavioural correlates of cognitive styles is to investigate individual differences in hypertext navigation (Barker & Barker, 2002, Graff, 2002). Graff (2002) notes that while numerous studies have been conducted on individual differences in navigational behaviour (e.g., Korhauer & Koubek, 1994; Lawless & Kulikowich, 1994), little research has been conducted as to why there are individual differences in navigational behaviour. Style researchers have only recently started to get involved in this area. Advocates of style believe that differences in hypertext navigation may reflect the different ways that an individual learns and these differences may in turn be associated with an individual's cognitive style. An individual's navigation behaviour can be assessed in a variety of ways including the ratio of different pages visited to the total pages visited, a ratio of the different pages visited to total number of pages and time spent on each page. Judgements on the depth of navigation and data from maps drawn by participants of how they remembered the hypertext pages to be linked can also be analysed in terms of complexity, density and accuracy (Graff, 2002). To date the effect of cognitive styles on hypertext navigation is still unclear, but this may be largely due to the use of the unreliable CSA as the measure of cognitive style (e.g., Graff, 2002; Barker, Kutar & Britton, 2002; Graff, 2001; Barker & Barker 2001).

Although this thesis suggests that more research is needed into the behavioural correlates of style as measured by the VICS and the Extended CSA-WA, it is also important to remember that Chapters 6-9 have shown that the VICS and the Extended CSA-WA have already met four of Riding's criteria for style validity. Namely independence of the style dimensions from one another, separate from intelligence, independent of personality and fulfilling the criteria of a 'style' (Riding, 1997). The relationship between style and observed behaviour is the first one that so far has not been met. The previous investigations used established personality and ability measures to test for potential associations with style but this was not the case with the current study. More established, or at least carefully planned, behavioural measures such as the reasoning task and the hypertext navigation tasks mentioned above should be designed and tested before a decision on whether or not the VICS and the Extended CSA-WA relate to observed behaviour is made.

Chapter 12

Individual Differences in Education

> "Today, as in the past, it appears that, of all the branches of psychology, differential psychology– the study of individual and group behavioural differences-is the most germane to the discussion of the problems of education."
>
> (Jensen, 1973, p.1).

Jensen's 1973 book titled 'Educational Differences' was one of the first to advocate the importance of individual differences to the field of learning and education. Up until then, the traditional method of assessing the effects and importance of various variables on learning was to make statistical comparisons between group means. Individual differences were often seen as "pesky statistical problems resulting from the wide range of scores" (Underwood, 1964, cited in Jensen, 1971, p.324).

The shift towards focusing on individual differences in learning is also increasingly being encouraged by government policy. In the United Kingdom, following the Dearing Report in 1997 and the government's policy of promoting 'Lifelong Learning', two projects are being pursued which encourage educational institutions and students to focus more closely on individual differences in the learning process. The first is the 'Own Learning Performance' initiative, which is part of the Key Skills Agenda aimed at schools and the second is the use of Progress Files, which is aimed at the Higher Education sector.

The government's Key Skills Agenda identified three key skills and three wider skills, which are "commonly needed for success in a range of activities in education, training, work and life in general" (QCA, 2000, p 1). The three key skills identified were 'communication', 'application of numbers' and 'information technology' while the three wider skills were 'working with others', 'improving own learning performance' and 'problem solving'. All schools are meant to be developing these key skills in their students either by integrating them into their existing curriculum or by running separate lessons that focus on them.

It is the key skill 'Improving Own Learning Performance' which is potentially the most relevant to style research, as it focuses on helping the student to understand and monitor their own learning and aims to develop independent learners with good processing and interpersonal skills (Key Skills Support Programme, 2000).

The purpose of the progress file (which was recommended by The National Committee of Inquiry in Higher Education, 1997) is to chart the achievements and progress of the individual and "provide a means by which students can monitor, build and reflect on their personal development" (National Committee of Inquiry in Higher Education, www.leeds.ac.uk/educol/ncihe). Personal Development Planning (PDP) is one aspect of the progress file concept, which is particularly focused on understanding and respecting individual differences in learning. PDP is defined as

> "A structured and supported process undertaken by an individual to reflect upon their own learning, performance and/or achievement and to plan for their personal, educational and career development. The primary objective for PDP is to improve the capacity of individuals to understand what and how they are learning, and to review, plan and take responsibility for their own learning, helping students:
>
> - become more effective, independent and confident self-directed learners;
> - understand how they are learning and relate their learning to a wider context;
> - improve their general skills for study and career management;
> - articulate personal goals and evaluate progress towards their achievement;
> - and encourage a positive attitude to learning throughout life."
>
> (http://www.qaa.ac.uk/crntwork/progfileHE/contents.htm, 2002)

The guidelines set suggest that Progress Files, which include PDPs, should be operational across the Higher Education system and for all Higher Education awards by 2005/06. Universities UK, Universities Scotland, the Standing Conference of Principals, the Learning and Teaching Support Network and QAA are all supposed to be working with others to help higher education institutions and academics develop Progress File policies and practices.

These two government initiatives, 'Own your own learning' and 'Personal Development Planning' Progress Files, highlight the current trend and increasing importance associated with assisting students to become aware of their own style and approach to learning. Furthermore, these initiatives are designed to make it clear to students what is required of them, but at the same time it puts the responsibility back on to the students to critically reflect and take ownership of their learning.

Given these developments, there is a growing need to find reliable and valid ways to help students become aware of their own style of learning. This challenge is also exacerbated by the government's strategy of increased participation in Higher Education and, in particular, to increase the access of 'non standard' learners (Andrews, Pheiffer, Green & Holley, 2002). This is resulting in a more diverse range of students with a wider range of abilities, which in turn may make it even more important to help students find their preferred way of learning so they do not get left behind.

The results of this thesis suggest that the VICS and the Extended CSA-WA may be one reliable and valid measure that can help inform students about their learning styles and in so doing provide a base for discussion about differences in learning style. As Entwistle (1986) said: "By giving students feedback about their own styles of learning and discussing the characteristic pathologies of such strategies, it is thought to be possible to help students develop a more versatile approach to learning" (p.215).

Although these government initiatives are to be welcomed and the VICS and the Extended CSA-WA may have a role to play in these projects, it is important to remember many factors other than the individual's learning preference or learning approach play an important part in successful learning such as ability, context, motivation, intentions, strategies, perception of the task, personality of the student and teacher, prior knowledge, and developmental stage (Entwistle, 1986). Indeed there are "many reasons why we should not expect to find general laws of learning, when individuals, content and context are all so different" (Entwistle, 1986, p.5).

This concern is not new. In 1899, the famous American psychologist and philosopher William James said

> "You make a great, a very great mistake, if you think that psychology, being the science of the mind's laws, is something from which you can deduce definite programmes and schemes and methods of instruction for immediate classroom use. Psychology is a science, and teaching is an art; and sciences never generate arts directly out of themselves. An intermediary inventive mind must make the application by using its originality."
>
> (James, 1899, pp 23-24, cited in Entwistle, 1986, p.6).

While James is not ruling out a link between psychology and education, his approach is somewhat cautious. He argues that an intermediary is needed to help translate psychological theory into classroom reality. In this sense, psychological research needs to demonstrate classroom relevance in order for it to begin to have educational significance. However, there is always going to be difficulty in extrapolating laboratory based experiments to the classroom, just as there are always going to be problems with lack of control in classroom, based experiments. It is also not easy to get educators to adopt new ideas, which have not been tested in situ. If psychological research is to have an effect on the classroom it needs to make intuitive sense to those in charge of it. As Entwistle (1986) suggests, "improvements in educational practice depend on sensitive interpretation and application of both more objective, codified forms of knowledge contained in psychological theory, and the traditional wisdom of the teacher" (p.18).

In other words, psychological and educational researchers cannot provide immediate solutions to practical classroom problems, but they can indirectly improve practice by working with teachers and students to change the way situations are interpreted. For example, making teachers and learners more aware of aspects of the teaching-learning process and by getting teachers to reflect and examine the research findings so that they can see the relevance of them and to their classroom (Entwistle, 1986).

This relevance is what Armstrong and Rayner (2002) refer to as valence. This means that the research is relevant in an applied practical context, that it has value and stands up in a real world context. In their words, it is "the degree to which research models or constructs are coherent, cohesive and consistent, providing access to meaningful as well as purposeful activity" (p.34). In this sense, valence is a shift from pure academic theory to something that is practical and useful.

Armstrong and Rayner (2002) believe that valence, reliability and validity are the three fundamental research goals which social science researchers should be concerned with. However, often the concept of valence is neglected. They believe that style researchers have to some extent fallen into a trap whereby the focus of their research is solely on test development, reliability, validity and effectiveness. They argue that as a result of this research, the "discourse in the field then becomes characterised by a defence of the faith and a belief in one version of the truth – a single, measure of psychometric assessment–in the established paradigm of positivism and a tradition of experimental psychology" (p.26). More research on valence is argued by Armstrong and Rayner to be the key to opening up the "theoretical tautology which is stifling the field" (p.26). This is not to say that researchers are not interested in showing the relevance of styles to business, management or education, but what is needed is argued to be a balanced theoretical discourse and the development of a methodology that focuses on valence, reliability and validity.

While this thesis has demonstrated that the VICS and the Extended CSA-WA have reliability and validity, the issue of valence is yet to be investigated. Future research on the VICS and Extended CSA-WA will need to include discussions with teachers and managers with the aim of conducting more research into the practical applications that these two tests might have in applied settings.

In conclusion, the study of individual differences in education and in particular individual differences in cognitive styles, is increasingly being acknowledged as important for the development of a learning culture in schools and higher education. This thesis suggests that the VICS and the Extended CSA-WA, being reliable and valid measures, might be able to play an important role in helping students to identify their preferred cognitive style. However, before this happens, more research is needed into the valence and practical applications of these two tests and in particular to the value they can add to the education process. Finally, this chapter warns that there are many other factors that affect the way students learn. Focusing on one aspect is not necessarily going to create the learning culture the government aspires to have. What is needed is a balance and at the very least an awareness of the various factors involved and their potential implications.

Chapter 13

How far have we come and where to next?

Following a summary of the main achievements of this thesis, some of the future challenges to the account presented are anticipated and suggestions for future work are given.

13.1 Achievements of the thesis

One of the most important findings of this thesis is that the verbal-imagery and wholistic-analytic dimensions of cognitive style exist, are stable and can be measured. The verbal-imagery and wholistic-analytic dimensions of style can be measured with the Verbal Imagery Cognitive Styles (VICS) test and the Extended Wholistic-Analytic Cognitive Styles Analysis (Extended CSA-WA) test and these measures appear to be valid, reliable and internally consistent. Furthermore, the VICS and the Extended CSA-WA are more reliable than Riding's (1991,1998) popular Cognitive Styles Analysis test, which also purports to measure the verbal-imagery and wholistic-analytic dimensions of cognitive style.

More specifically, Chapter 1 briefly outlined the history and development of cognitive styles research and found that many of the style measures lacked empirical evidence for reliability and validity. It also suggested that many of the proposed style measures could be argued to measure two broad style dimensions: verbal-imagery and wholistic-analytic (Riding & Cheema, 1991). Chapter 2 explained that Riding's Cognitive Style Analysis (CSA) was a popular test which measured these two dimensions and had been subjected to a substantial amount of empirical research, leading to claims that it was a valid measure of cognitive style. Chapter 3 showed that despite the CSA's popularity, the verbal-imagery and wholistic-analytic style preferences that the CSA measured were not reliable ($\underline{r} < .34$) or internally consistent ($\underline{r} < .54$) measures. However, if the CSA's wholistic-analytic test was doubled in length to make, what this thesis refers to as the Extended CSA-WA, the wholistic-analytic measure of style became more stable (internal consistency r = .69). These findings were repeated in Chapter 7 with a new larger sample size (N = 100).

Chapter 4 investigated whether a reliable wholistic-analytic cognitive style could be detected using Navon stimuli in an inspection time paradigm. The results suggested that inspection time might well be a suitable means of detecting style preferences, as the inspection time test ratio overall was similar in reliability (r = .60) to the wholistic-analytic dimension ratio of the CSA (r = .71). However, the small sample size (N = 20) meant the result lacked power and more research was argued to be needed to confirm these findings. The thesis then turned its attention to redesigning a more reliable verbal-imagery cognitive style dimension, which had consistently been shown to be unreliable on the CSA in Chapter 3.

Chapter 5 outlined a new verbal-imagery test, which was modelled on similar principles to Riding's CSA test of the verbal-imagery dimension. This new test, called the Verbal-Imagery Cognitive Styles (VICS) test, was found to be considerably more reliable (r_s = .66) and internally consistent (r_s = .71) than the verbal-imagery dimension of the original CSA. Having demonstrated the reliability and internal consistency of the VICS and the Extended-CSA-WA and confirmed these findings in samples of 50 and 100 participants, Chapters 7-11 set out to investigate the validity of the two tests. The results indicated that both tests were largely independent of established measures of personality (r < .38) (Chapter 8), a variety of mental ability tests (r < .28) (Chapter 9), and two other popular measures of style (r < .29) (Chapter 9). Chapter 11 attempted to show that the VICS and the Extended CSA-WA were also related to observed behaviours but no relationship was found, probably because of experimental design and procedural errors. Overall the results from Chapters 7-11 indicated that the Extended CSA-WA and the VICS appear to be independent of personality, intelligence, and two other popular style measures.

Finally, Chapter 12 outlined some of the current attempts to integrate learning and cognitive styles into education and it suggested that the VICS and the Extended CSA-WA might be suitable tests to assist with this process. In addition, Chapter 12 highlighted the importance of showing real world application of cognitive style theory and measurement.

13.2 Study Limitations

There are two main criticisms that could be leveled at the account of the VICS and Extended CSA-WA in this thesis. The first concern is theoretical and the second is practical.

One possible criticism is that this thesis has just added yet another style test to the ever-increasing cognitive style wasteland. Desmedt and Vackle (2002) argue that adding more cognitive or learning style models to those that already exist cannot be considered progress. They argue that "further applications of cognitive and learning styles can only be justifiably developed if the muddle of different existing theoretical orientations is cleared up" (p.3). Although the VICS and, to some extent, the Extended CSA-WA are new tests of cognitive style, they have not been dreamed up like one of Lewis' (1976) fail safe recipes for designing a style (see Chapter 1). Instead, the Extended CSA-WA was an extension of Riding's existing test of the wholistic-analytic dimension and the VICS test was modelled on the same principals as Riding's verbal-imagery dimension of the CSA. Therefore, rather than adding a completely new style to the pile, the VICS and the Extended CSA-WA can be argued to be building on and verifying an existing and popular model.

If anything, this thesis has helped to verify one of the existing theoretical frameworks. That is, this thesis provides support for the existence of two broad dimensions (verbal-imagery and wholistic-analytic) proposed by Riding and Cheema in 1991 and it provides evidence that they are stable, internally consistent and valid. To some extent the wholistic-analytic dimension has never really been disputed as it has been the basis of many style tests (Desmedt & Vackle, 2002) and has been repeatedly demonstrated in cognitive and social psychology (Monaghan, 2000). However, in the past, the difficulty with the wholistic-analytic dimension was in finding a reliable test that was not measuring ability. The Extended CSA-WA is the first test to overcome both of these problems (i.e., it is reliable and independent of ability). Therefore, the Extended CSA-WA's development is another one of the important achievements of this thesis. Arguably, what this thesis adds most however, is conformation that there are stable and measurable individual differences in the verbal-imagery cognitive style, which is a less established dimension, and these differences, like the wholistic-analytic differences, cannot be explained by individual difference in personality or mental ability.

A second criticism of this thesis is that the VICS and the Extended CSA-WA have not been operationalised as measuring individual differences in the real world. Therefore the findings of this thesis cannot currently be applied outside of the laboratory and should not be heralded as though they could, until there is supporting evidence. As noted in Chapter 12, Armstrong and Rayner (2002) also warn against falling into a theoretical tautological trap whereby "the model of style is defined by the instrument used to measure it that was in turn, validated by the theory that supports the claim for construct validity" (p.26). One way out of this cycle is to find "any reference to the real-world through application, operationalisation or the equally important notion of valued meaning (valence) which might arguably open up the theoretical tautology that is stifling the field" (p.26).

One of the best places to start to look for practical applications and valued meaning is the field of education and management. It is these fields that are argued to be particularly relevant to cognitive styles. Indeed, it is to these environments that the CSA is sold with the slogan "Maximise personal potential through cognitive styles awareness!" (CSA, Learning & Training Technology). Research using the VICS and the Extended CSA-WA needs to be conducted in these settings in order to see if the two tests have the practical applications that style researchers so often speak of. If practical applications are found for the VICS and the Extended CSA-WA, then there is more reason to sound the trumpet and argue for more attention to be paid to the two measures.

13.3 Future research

Cattell (1957) said "the pragmatic proof that a thing 'works' carries the sure implication that we have something caught in our scientific net, but this may still leave us a long way from landing the catch" (p.5). As noted above, too often style researchers publish new tests and then abandon further careful investigation into the psychometric properties of the test and the practical applications of them (Curry, 1990a). Indeed it is this kind of approach that has, in part, stifled the progression of cognitive style research and led to a proliferation of style labels in the literature with little or no published evidence of their reliability, validity and valence. Furthermore, this lack of supporting empirical evidence and practical relevance has in turn often led to their downfall as measures of style.

More research on the VICS and Extended CSA-WA needs to be conducted in four main areas: the potential applications of tests; the nature of the test's cognitive elements that lead to stable individual differences; the relationship that the tests have with existing neurocognitive and cognitive models; and the independence of the tests from other related measures and concepts.

13.3.1 Applications

The importance of finding real-world applications for styles was mentioned above. One place where researchers might start to find them is the design of hypertext navigation and multimedia environments (Graff, 2001; 2002, Barker & Barker, 2001; Parkinson & Redmond, 2001). Computer systems are increasingly being designed for use in an individual way. Currently this is usually based on the user's personal characteristics or on how well they perform whilst using a particular application (Barker & Barker, 2002). By designing computer environments or multimedia applications which take into account the individual differences in the cognitive styles of their intended user's, it may be possible to reinforce areas of the users weakness and take advantage of the users strengths (Barker & Barker, 2002).

Another potential area of real world application is to investigate the way individual's approach and solve problems. If individual differences in cognitive style are reflected in the way that people solve problems, we might be able to use this information to help communicate complicated ideas in the classroom and in business settings more quickly and effectively.

13.3.2 Cause of individual differences

The causes of individual differences can in part be examined by investigating whether individual differences in cognitive style can be measured with a different test question and with different test stimuli than those used in the VICS and the Extended CSA-WA. In this sense, the wholistic-analytic inspection time task outlined in Chapter 4 looked promising as it showed stable individual differences in a simple task, that to a large extent prevented higher order processing. A similar wholistic-analytic task using shapes similar to those in the Extended CSA-WA could be one extension of this study. In any case, more inspection time research, with a larger sample, looking at the wholistic-analytic and verbal-imagery style differences is one interesting line of inquiry.

Another, more reductionistic approach, would be to use fMRI scans or ERP recordings to look at whether changes to the nature of the test stimuli are mirrored by neurological changes in the brain or whether different levels of activity in the brain are associated with different cognitive styles. More specifically, an fMRI study might reveal different patterns of activation / deactivation to specific stimuli in people with different cognitive styles. Using ERP studies one could hypothesise different wave form patterns in people with different cognitive styles. It would also be interesting to conduct heritability studies looking at whether monozygotic and dyzygotic twins have similar cognitive styles. These types of investigations are important if we are to get any closer to understanding what it is that the VICS and Extended CSA-WA test are really measuring, how these individual differences are generated and how hard wired these styles are.

13.3.3 Relationships with other cognitive models

It is also important for future research to examine whether the VICS test ties into the existing and more vigorous field of cognitive and neurocognitive psychology and in particular into existing cognitive models. Miller's 1987 article 'Cognitive Styles: an integrated model' makes some steps in this direction by linking some conceptions of style with information processing models of cognition and in particular with perception, memory and thought (see Figure 12.1 above). Although this is a step in the right direction, most of the cognitive style examples Miller uses are dated or lack empirical evidence. It would be well worth researchers taking another look at Miller's model to see what the last 15 years of style research can add to his model and to see if links between the VICS and the Extended CSA-WA can be made. There are also other cognitive architectures that are yet to be explored for links with cognitive style. For example, links could be found with Paivio's Dual Coding theory (1971; 1986) and Baddeley and Hitch's (1974) Working Memory.

13.3.4 Relationships with other related measures and concept

The relationships that the VICS and the Extended CSA WA has with other similar measures needs to be investigated. In particular, the VICS and Extended CSA-WA need to be compared with other style tests that argue to measure similar dimensions, especially those with some evidence of validity, reliability or valence (e.g., Myers Briggs; Field dependence-independence etc.).

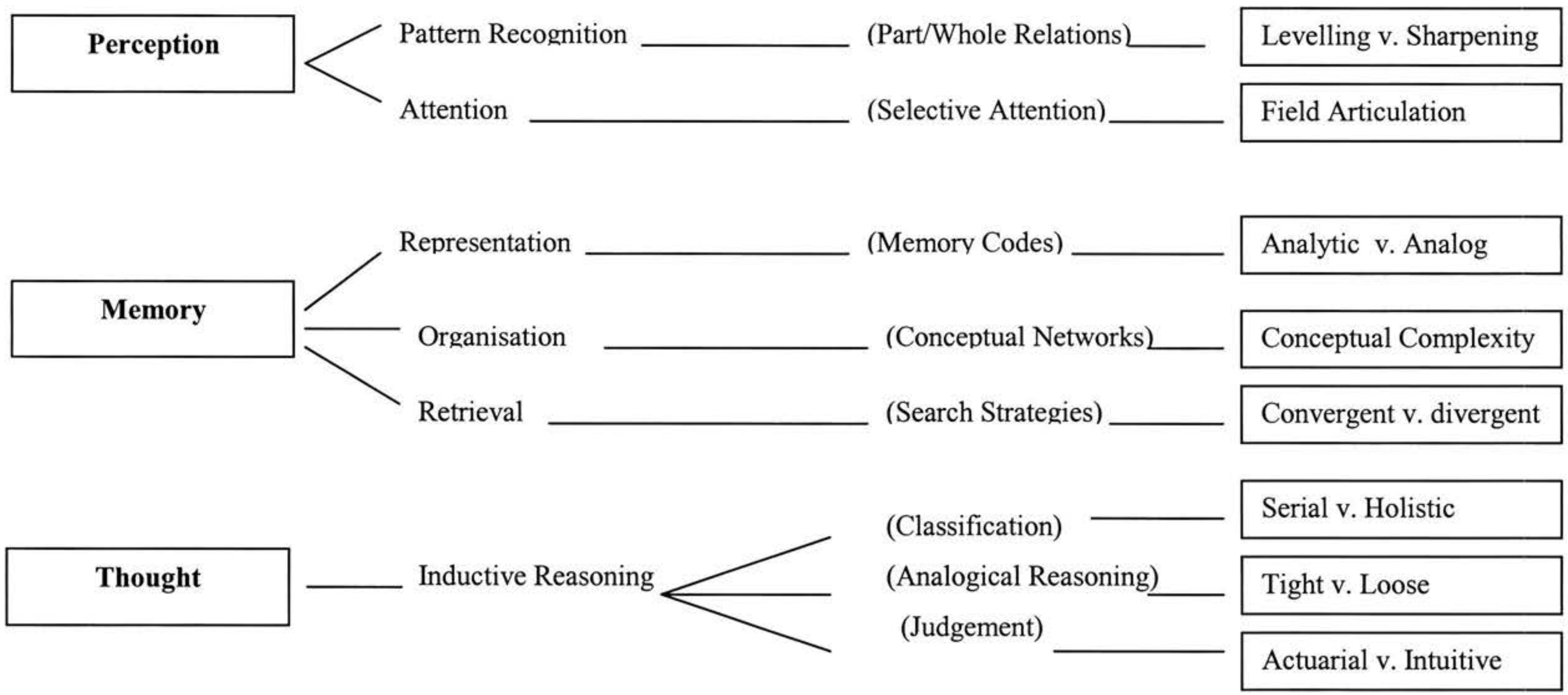

Figure 12.1 Miller's (1987) model of cognitive style and cognitive processes (p.253).

Chapter 13. How far have we gone and where to next?

In conclusion, this thesis has presented a new test of verbal-imagery cognitive style (VICS test) and extended an existing test of wholistic-analytic style (Extended CSA-WA) which are more internally consistent and reliable than the popular verbal-imagery and wholistic-analytic test of the CSA. More research however, is needed on the practical applications and empirical properties of the new VICS and the Extended CSA-WA test, especially if we are to get any closer to understanding why individual differences in performance on these dimensions exist, whether they fit within any consensual framework and how they can be applied to the real world. Although there are several areas that require more investigation, these suggestions for future research should not distract from this thesis' main and novel finding that a new test has been designed that measures stable individual differences on a verbal-imagery dimension and an existing test of the wholistic-analytic dimension has been improved. Furthermore, both of these tests appear to be independent of intelligence, personality and two other popular style related measures. Now we need to find out more about the nature, causes and practical applications of these style differences.

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Appendix 1

Table 1

Subject Median Reaction Times (ms) on each version of the test (CSA-A, CSA-B), each section (verbal, imagery, wholistic, analytic) and each session (1 and 2)

Subject	CSA-A, Verbal, S1	CSA-A, Imagery, S1	CSA-A, Wholistic, S1	CSA-A, Analytic, S1	CSA-B, Verbal, S1	CSA-B, Imagery, S1	CSA-B, Wholistic S1	CSA-B, Analytic, S1	CSA-A, Verbal, S2	CSA-A, Imagery, S2	CSA-A, Wholistic, S2	CSA-A, Analytic, S2	CSA-B, Verbal, S2	CSA-B, Imagery, S2	CSA-B, Wholistic, S2	CSA-B, Analytic, S2
1	1501.5	2142.5	2210	1637.5	1961	2159.5	2342.5	1819.5	2143	1502	1736	1207.5	1765.5	1653.5	1336	1359.5
2	2635	2509.5	3692	1543	2358.5	2417.5	1648.5	1414.5	2456	1910	1538.5	1221	1697.5	1885.5	1401	1440
3	2572	3113	2598	2344	4583.5	4596.5	3843.5	3071	2189.5	2808	3285	2213.5	3235	2800.5	3412	2463
4	2222	2569.5	2496	1988	2447.5	2125	1686	1491.5	1329	2474.5	1472	1705.5	2818.5	2897	1807.5	2056
5	3896.5	2976.5	2953.5	2187.5	3278	3062	2288	2460	1507.5	2490	1935	1748	2717	2624	2586.5	2047
6	2203	2537.5	1254.5	1408.5	3473.5	3467.5	2222	1524	1190	2228	1019	1177	2004	2074	1166.5	1147.5
7	2330.5	2003	1196	1076.5	1598.5	1368.5	1289.5	1041	1304	1303	899	896.5	1569	1519.5	1116	938.5
8	1497.5	2071.5	1092.5	1272	2184	2722.5	1653.5	1072	1847.5	1487	934.5	987	1460	1454.5	1005.5	1016.5
9	1844	1672	1351	1737.5	1445.5	1393.5	1143	1180	1899.5	1405	1100.5	1193	1412.5	1169.5	1125.5	1229.5
10	1479.5	1580	1226	1015	2284.5	1971.5	1661.5	1316.5	1904	1395.5	1042	892.5	1183.5	1080.5	898.5	971.5
11	1825	2025	2062.5	1339.5	1774	1628	1425.5	1132	2669.5	1398.5	1118	946.5	1361	1711	1159	1011
12	2104	1904.5	892.5	984.5	1725	1583	910.5	881	1236	1335.5	844	800	1693.5	1579	896.5	848.5
13	3275.5	2980	1458.5	1332	2602.5	2736.5	1352	1081.5	1489.5	2009.5	1135	889.5	2059	2648	1116.5	957.5
14	2684	2387	1597	1635.5	2192	1950	1163	1167	1415.5	1713.5	1023.5	989.5	2061.5	1860.5	1225	1206
15	2134.5	2047.5	2115.5	1563	2761	2894.5	3016	2024	2224	1688.5	1406.5	1215	1328.5	1443	1608	1760
16	2116.5	1900	878	806	2354	2563.5	1352	923	2590	2110.5	881	848.5	1823	1690	940.5	861.5
17	1923	2222.5	1175.5	1310.5	2634	2835	1758.5	1718.5	1212	2363	1798	1333.5	1558.5	1755.5	1399.5	1346.5
18	2451	2193.5	1368	1054.5	4235.5	3455.5	2632.5	1740	1914	3038.5	1375.5	1159	2401.5	2172	1559	1230
19	2252	2498.5	1659.5	1505	3385	3266.5	2401.5	1977.5	1823.5	2046	1496.5	1527.5	2116.5	2152	1653	1264
20	1784.5	2469	1734	1054.5	3312	3685.5	2309	1239	1873.5	2628	1862.5	1061	2046.5	1934.5	2014.5	1134
21	2804.5	2513.5	1776	1554.5	2638	2313.5	2152.5	1791	1763.5	1917.5	1394	1239.5	2479	2329	1882	1462
22	2956	2741	3345.5	2605	3279	3799	4707	2781.5	1343.5	2473.5	3269	2279	2805	2436.5	2679.5	2152
23	4047	3657.5	4445	3319	4804.5	4327	4735.5	2893.5	1542.5	2727	3976	1922	2328	2522.5	2562	2233
24	4211.5	3923.5	4446.5	2276	3531.5	4006	1644.5	1702	1517.5	3074	3043.5	2172	3072	2806	2268.5	1715.5
25	1764.5	1819.5	1138.5	1278	1489	1376.5	1173.5	989.5	2379	1119	915.5	846.5	1290.5	1276	1139	907
26	2627.5	2159	1380.5	1020.5	2236	2081.5	1001	945	1778.5	1471.5	1041.5	779	1800.5	1909	1003.5	838.5

Tables 1 continues

Table 1 continued

Subject	CSA-A, Verbal, S1	CSA-A, Imagery, S1	CSA-A, Wholistic, S1	CSA-A, Analytic, S1	CSA-B, Verbal, S1	CSA-B, Imagery, S1	CSA-B, Wholistic, S1	CSA-B, Analytic, S1	CSA-A, Verbal,S 2	CSA-A, Imagery, S2	CSA-A, Wholistic, S2	CSA-A, Analytic, S2	CSA-B, Verbal, S2	CSA-B, Imagery, S2	CSA-B, Wholistic, S2	CSA-B, Analytic, S2
27	1699	1788	919	949	2104.5	1725.5	1184	1117.5	1857	1237	755.5	794	1431.5	1247	930	844.5
28	2487	2392	1402.5	1326.5	1707	1609.5	1641	1168.5	1008.5	1305.5	1188	966.5	1542.5	1318	1297	1086
29	1853	1835	1771.5	1598	2921	2964	2348	1944.5	1682.5	1719	1709.5	1341.5	1971	1768	1561.5	1414.5
30	2412	2351.5	1901	1533	1901.5	2000.5	1404.5	1334	2831	2012	1279	1376	2258	2110	1342.5	1126.5
31	1307	1542.5	1320.5	1053	1605.5	1633	1451.5	1098.5	1986	1318.5	1323.5	1069.5	1371	1437	1183.5	991
32	3681.5	3151	3424	1472	2726	2307	1518.5	1362.5	1556.5	2341.5	1307.5	1284	2977	2536.5	1558.5	1416.5
33	3312	3091	2018	1660	4073.5	2958.5	3424.5	2406	1446	2620	1791	1607	2516.5	2278.5	1539	1297
34	1660.5	1798	1192	1435.5	1571	1833	1178.5	1171	1736.5	1437.5	861.5	881.5	1431.5	1629	996.5	1062.5
35	3167.5	2963.5	2576.5	2390	4007	3388.5	3485	2206	2220.5	2334	2055	1818	2818	2914	2724.5	1651.5
36	2254	2907.5	1838.5	1632	2075.5	2342	1247	1113	2262	1873.5	1087	966.5	1960	2290.5	1133	1302.5
37	2539	2378	2349.5	2359.5	2227	2138.5	1870	1531	3031	1924.5	2161	1937.5	1818.5	1879	2282	1630.5
38	2576.5	1639	1384.5	1342	2208.5	2619.5	1503.5	1136.5	1782	2159.5	1473.5	1449	1676.5	1704.5	1426.5	1228
39	2788	3095.5	4265	2729	2294.5	2430.5	3037	1363.5	2388	1747	1531	1261	1901	1899	1854.5	1282
0	2002.5	2011	1064	996.5	1717.5	1997.5	1090.5	935	2632.5	1985	971.5	900.5	1991	2289.5	1220.5	928.5
41	1463	1767.5	1045.5	1118	1915	1600	1307.5	1094	3181.5	1599.5	1056	878.5	1496	1439	1277	987.5
42	2317.5	2721.5	1312	1260.5	2149.5	1728	1356.5	1248.5	1463.5	1538.5	1346	1066	1814	1695	1210.5	1042
43	2283.5	1814	1049	1066.5	2500	2573.5	1930.5	1546.5	1553	1410	970	1064.5	1355.5	1466	1052.5	1095.5
44	3371	3857.5	2058.5	1932.5	2939.5	2844	1673	1555	1334	2724	1414	1470	2344	2493.5	1528	1292
45	2005.5	1842	1340.5	1295	2599.5	2227	1925	1431.5	2805	1802	1514	1312	1646	1771	1634	1319.5
46	3478	3143	3102	1671	3064	2904.5	1393.5	1260.5	2307	1975.5	1773.5	1578	2458.5	2684	2183	1257.5
47	2265	2446.5	1358.5	1420.5	2692	3384	2110	1226.5	2384.5	2056	1233	1304.5	1856	1667.5	1255.5	1199.5
48	3407.5	2539.5	2021.5	1527.5	2209.5	1944	1483	1072.5	1714	1767.5	1024.5	1280	2004	2352	1411.5	1062
49	1721	1915	1079.5	1067.5	2278.5	2233.5	1605	1252.5	2126	2117.5	1181.5	1049.5	1715	1659	1138.5	1174
50	1349	1206.5	964	804	1170	1088.5	1120	975	2346.5	927	902	744	1091	1033.5	977.5	812

Appendix 2

Appendix 3

Formula for the calculation for name agreement

$$\sum_{i=1}^{k} pi \log_2(1 - p_i)$$

Where k = to the number of different names given to each picture
Pi is the proportion of subjects giving each name

Table 1
Spearman's correlation coefficients between the style ratios for the CSA-A and the CSA-B for each section of the test (verbal, imagery) and for each session (S1, S2), p values are given in brackets. Items in bold show the correlations within the same test

	1	2	3
CSA-A, Verbal-imagery Dimension, S1			
CSA-A, Verbal-imagery Dimension, S2	**.320** (.027)		
CSA-B, Verbal-imagery Dimension, S1	-.321 (.026)	.166 (.258)	
CSA-B, Verbal-imagery Dimension, S2	.182 (.217)	.303 (.036)	**.107** (.470)

Table 2
Table of the Spearman's correlations coefficients between the median reaction times in ms for the Combined CSA-A and the CSA-B test at each section (verbal, imagery) and session (1, 2). Correlations in bold show the test-retest correlations within the same test. All correlations were significant at $p < .001$

	1	2	3
1. C-CSA Verbal, S1			
2. C-CSA, Verbal, S2	**.848**		
3. C-CSA, Imagery, S1	.941	.821	
4. C-CSA, Imagery, S2	.840	.929	**.818**

Table 3
Spearman's correlations coefficients for the C-CSA and the VICS ratios at session 1 and session 2. Items in bold show the correlations within each test.

	1	2	3
1. C-CSA Verbal Imagery ratio S1			
2. C-CSA Verbal Imagery ratio S2	**.212** (.152)		
3. VICS Imagery-Verbal ratio S1	-.138 (.355)	-.018 (.906)	
4. VICS Imagery-Verbal ratio S2	-.117 (.432)	-.030 (.842)	**.660** (.000)

Appendix 4

Table 1.
Spearman's Correlations (p values) between VICS verbal-imagery and Extended Wholistic-Analytic style and IPIP, EPQ-R, and IVE personality scales. Underlined correlations are significant, correlations in bold show the significant correlations with cognitive style.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	VICS Verbal Imagery (S1)															
2	VICS Verbal Imagery (S2)	**.544 (.000)**														
3	E-CSA-Wholistic Analytic (S1)	-.078 (.441)	-.105 (.297)													
4	E-CSA-Wholistic-Analytic (S2)	-.047 (.640)	.083 (.414)	**.546 (.000)**												
5	Extraversion (IPIP)	-.008 (.941)	-.010 (.923)	-.158 (.115)	-.032 (.749)											
6	Agreeableness (IPIP)	**-.301 (.002)**	-.189 (.060)	-.014 (.887)	.082 (.417)	.334 (.001)										
7	Conscientiousness (IPIP)	-.071 (.481)	-.092 (.361)	.166 (.099)	.105 (.296)	-.037 (.712)	.268 (.007)									
8	Emotional stability (IPIP)	.069 (.498)	.107 (.288)	**-.281 (.005)**	-.118 (.244)	.325 (.001)	.186 (.063)	.132 (.189)								
9	Intellect/ imagination (IPIP)	-.142 (.160)	.024 (.813)	-.062 (.541)	.040 (.693)	.319 (.001)	.165 (.099)	.148 (.139)	.123 (.222)							
10	Strong mindedness (EPQ-R)	.137 (.175)	.076 (.451)	**-.368 (.000)**	-.164 (.102)	.020 (.840)	-.135 (.177)	-.165 (.100)	.129 (.199)	.084 (.406)						
11	Extraversion (EPQ-R)	.107 (.288)	.144 (.154)	-.152 (.131)	-.087 (.389)	.806 (.000)	.166 (.097)	-.079 (.431)	.320 (.001)	.145 (.149)	.010 (.919)					
12	Emotional stability (EPQ-R)	-.067 (.508)	.019 (.853)	.165 (.100)	.096 (.342)	-.401 (.000)	-.111 (.270)	-.146 (.146)	-.806 (.000)	-.028 (.781)	-.085 (.395)	-.366 (.000)				
13	Lie scale (EPQ-R)	-.043 (.669)	-.037 (.716)	.023 (.822)	-.038 (.706)	-.102 (.310)	.089 (.375)	.076 (.451)	.034 (.733)	-.113 (.262)	.044 (.660)	-.038 (.703)	-.009 (.929)			
14	Impulsiveness (IVE)	.016 (.875)	.171 (.091)	-.185 (.068)	-.021 (.833)	.251 (.012)	-.183 (.068)	-.348 (.000)	-.029 (.773)	.073 (.471)	.186 (.065)	.270 (.007)	-.013 (.896)	-.109 (.281)		
15	Venturesomness (IVE)	.094 (.357)	.142 (.160)	-.132 (.194)	-.061 (.547)	.050 (.623)	.018 (.862)	-.105 (.297)	.350 (.000)	.046 (.647)	.433 (.000)	.183 (.069)	-.248 (.013)	.056 (.583)	.267 (.007)	
16	Empathy (IVE)	**-.306 (.002)**	**-.220 (.028)**	**.287 (.004)**	**.238 (.018)**	-.100 (.324)	.095 (.345)	-.044 (.666)	-.281 (.005)	.027 (.788)	-.269 (.007)	-.149 (.140)	.314 (.001)	.109 (.282)	.117 (.247)	-.115 (.253)

Appendix 5

Table 1

Spearman's correlations (p values) between VICS verbal-imagery ratio and Extended CSA-Wholistic-Analytic style ratio and the total ability scores for eight ability measures. Underlined correlations are significant. Correlations in bold show the significant correlations between ability and style.

		1	2	3	4	5	6	7	8	9	10
1	VICS Verbal-Imagery, S1										
2	VICS Verbal Imagery, S2	.544 (.000)									
3	E-Wholistic-Analytic, S1	-.078 (.441)	-.105 (.297)								
4	E-Wholistic Analytic, S2	-.047 (.640)	.083 (.414)	.546 (.000)							
5	Total Vocabulary	-.004 (.966)	.151 (.135)	-.129 (.204)	-.025 (.803)						
6	Total Card Rotation	.042 (.679)	.282 (.004)	-.031 (.758)	-.112 (.268)	.156 (.120)					
7	Total Paper Folding	-.022 (.826)	.227 (.023)	-.107 (.292)	.013 (.897)	.080 (.432)	.346 (.000)				
8	Total Controlled Assoctn	-.025 (.808)	.092 (.377)	-.016 (.878)	-.033 (.748)	.350 (.000)	.246 (.016)	.277 (.006)			
9	Total Gestalt Completion	-.054 (.592)	.159 (.115)	-.259 (.009)	-.100 (.325)	.178 (.076)	.255 (.010)	.382 (.000)	.130 (.207)		
10	Total Find A's	-.157 (.119)	-.026 (.798)	.109 (.281)	.040 (.692)	-.008 (.941)	.293 (.003)	.148 (.141)	.144 (.161)	.144 (.150)	
11	Total Hidden Figures	-.092 (.368)	.062 (.539)	.032 (.756)	.012 (.903)	.091 (.369)	.238 (.017)	.261 (.009)	.255 (.013)	.216 (.031)	.236 (.018)

Table 2

Pearson's correlations (p values) between the VICS verbal-imagery style ratios and Extended CSA wholistic-analytic style ratios and eight ability measures. Each ability measure is separated into 2 parts. Underlined correlations are significant. Correlations in bold are the significant correlations between style and ability.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	VICS Verbal-Imagery, S1														
2	VICS Verbal-Imagery, S2	**.549 (.000)**													
3	E-Wholistic-Analytic, S1	.037 (.714)	-.085 (.400)												
4	E-Wholistic-Analytic, S2	.024 (.811)	.094 (.353)	**.554 (.000)**											
5	Adv Vocab Part 1, S1	.006 (.954)	.064 (.529)	-.058 (.566)	-.085 (.402)										
6	Adv Vocab Part 2, S1	.022 (.832)	.161 (.111)	.006 (.953)	.022 (.828)	.720 (.000)									
7	Extnd Vocab Part 1, S2	-.121 (.240)	-.046 (.658)	-.004 (.970)	.022 (.830)	.650 (.000)	.571 (.000)								
8	Extnd Vocab Part 2, S2	.097 (.348)	**.216 (.034)**	-.042 (.684)	.064 (.534)	.663 (.000)	.585 (.000)	.669 (.000)							
9	Card Rotation, Part 1	.043 (.669)	**.200 (.046)**	-.039 (.698)	-.155 (.123)	.124 (.218)	.097 (.338)	.010 (.923)	.029 (.781)						
10	Card Rotation Part 2	.106 (.294)	**.247 (.013)**	-.057 (.575)	-.042 (.679)	.201 (.045)	.106 (.292)	.219 (.031)	.096 (.349)	.649 (.000)					
11	Paper Folding Part 1	.052 (.609)	**.266 (.007)**	-.015 (.884)	.161 (.110)	.087 (.389)	.079 (.433)	.184 (.071)	.102 (.320)	.281 (.004)	.348 (.000)				
12	Paper Folding Part 2	-21 (.230)	.124 (.218)	-.110 (.277)	-.099 (.328)	.068 (.500)	.075 (.456)	.139 (.174)	.048 (.643)	.311 (.002)	.266 (.007)	.696 (.000)			
13	Controlled Assoctn Pt 1	.061 (.558)	.156 (.131)	.011 (.916)	-.085 (.414)	.257 (.011)	.154 (.135)	.200 (.054)	.126 (.226)	.318 (.002)	.397 (.000)	.264 (.009)	.193 (.059)		
14	Controlled Assoctn Pt 2	.033 (.750)	.078 (.450)	-.015 (.883)	-.051 (.627)	.435 (.000)	.314 (.002)	.264 (.010)	.285 (.005)	.040 (.699)	.133 (.195)	.191 (.063)	.182 (.076)	.445 (.000)	

Table 2 continued

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15	Gestalt Completion Pt 1	-.115	.011	-.160	.009	.104	.187	.160	.067	.218	.335	.227	.285	.141	.064					
		(.256)	(.912)	(.113)	(.931)	(.302)	(.062)	(.118)	(.513)	(.029)	(.001)	(.022)	(.004)	(.170)	(.536)					
16	Gestalt Completion Pt 2	.037	**.222**	**-.262**	-.114	.049	.162	.179	.037	.125	.265	.261	.201	.040	-.013	.375				
		(.715)	**(.026)**	**(.009)**	(.257)	(.632)	(.108)	(.080)	(.719)	(.213)	(.007)	(.008)	(.044)	(.702)	(.899)	(.000)				
17	Finding A's Part 1	-.064	-.046	-.025	-.049	.012	-.024	-.026	-.081	.267	.258	.150	.215	.197	.036	.128	.158			
		(.530)	(.653)	(.806)	(.626)	(.903)	(.809)	(.797)	(.431)	(.007)	(.009)	(.134)	(.031)	(.054)	(.730)	(.201)	(.114)			
18	Finding A's Part 2	-.171	-.043	.111	.146	.029	.086	.091	-.052	.198	.212	.164	.169	.230	.033	.020	.176	.615		
		(.088)	(.668)	(.270)	(.147)	(.776)	(.396)	(.375)	(.613)	(.047)	(.033)	(.102)	(.092)	(.024)	(.748)	(.844)	(.079)	(.000)		
19	Hidden Pattern Part 1	.040	.069	-.051	.018	.125	.112	.156	-.010	.253	.283	.239	.255	.295	.244	.134	.154	.206	.278	
		(.694)	(.496)	(.617)	(.861)	(.218)	(.270)	(.130)	(.925)	(.011)	(.004)	(.017)	(.010)	(.004)	(.017)	(.185)	(.125)	(.040)	(.005)	
20	Hidden Pattern Part 2	-.113	-.066	.065	-.021	.133	.076	.242	.054	.131	.222	.223	.205	.304	.071	.104	.123	.165	.291	.716
		(.265)	(.519)	(.523)	(.838)	(.188)	(.457)	(.018)	(.599)	(.194)	(.026)	(.025)	(.041)	(.003)	(.494)	(.301)	(.224)	(.102)	(.003)	(.000)

Table 3

Spearman's correlations (p values) between VICS verbal-imagery style ratio and Extended Wholistic-Analytic style ratio and eight ability measures. Each ability measure consists of 2 parts. Underlined correlations are significant. Correlations in bold show the correlations between part 1 and 2 of the ability tests and style.

1	VICS Verbal-Imagery, S1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	VICS Verbal-Imagery, S2	**.544** **(.000)**															
3	E-Wholistic-Analytic, S1	-.078 (.441)	-.105 (.297)														
4	E-Wholistic-Analytic, S2	-.047 (.640)	.083 (.414)	**.546** **(.000)**													
5	Advanced Vocab Part 1, S1	-.015 (.887)	.045 (.655)	-.137 (.177)	-.133 (.189)												
6	Advanced Vocab Part 2, S1	.034 (.739)	.178 (.078)	-.082 (.420)	.006 (.951)	.716 (.000)											
7	Extnd Vocab Part 1, S2	-.125 (.224)	-.004 (.970)	-.089 (.390)	.009 (.929)	.665 (.000)	.561 (.000)										
8	Extnd Vocab Part 2, S2	.078 (.448)	**.223** **(.029)**	-.117 (.258)	.052 (.616)	.651 (000)	.603 (.000)	.647 (.000)									
9	Card Rotation, Part 1	.013 (.901)	**.238** **(.017)**	-.029 (.776)	-.171 (.088)	.132 .(191)	.117 (.247)	.064 (.532)	.062 (.545)								
10	Card Rotation Part 2	.061 (.546)	**.273** **(.006)**	-.026 (.800)	-.024 (.811)	.155 (.124)	.092 (.361)	.199 (.050)	.075 (.467)	.672 (.000)							
11	Paper Folding Part 1	.062 (.542)	.272 (.006)	-.028 (.782)	.172 (.087)	.075 (.461)	.088 (.386)	.182 (.074)	.072 (.484)	.264 (.008)	.323 (.001)						
12	Paper Folding Part 2	-.099 (.326)	.140 (.166)	-.186 (.064)	-.140 (.165)	.043 (.674)	.057 (.573)	.185 (.069)	.069 (.502)	.301 (.002)	.280 (.005)	.623 (.000)					
13	Controlled Assoctn Pt 1	-.047 (.649)	.156 (.131)	-.012 (.905)	-.033 (.752)	.260 (.011)	.195 (.057)	.237 (.022)	.165 (.111)	.330 (.001)	.418 (.000)	.229 (.025)	.172 (.093)				
14	Controlled Assoctn Pt 2	-.010 (.922)	.031 (.763)	-.040 (.704)	-.045 (.667)	.393 (.000)	.261 (.010)	.252 (.014)	.285 (.005)	.050 (.627)	.108 (.297)	.199 (.052)	.201 (.050)	.437 (.000)			
15	Gestalt Completion Pt 1	-.044 (.663)	.092 (.363)	-.195 (.052)	-.050 (.621)	.138 (.170)	.209 (.037)	.176 (.085)	.082 (.423)	.267 (.007)	.321 (.001)	.271 (.006)	.404 (.000)	.190 (.064)	.071 (.489)		

Table 3 continues

Table 3 continued

16 Gestalt Completion Pt 2	.002	**.211**	**-.209**	-.084	.118	.198	.199	.029	.091	.159	.332	.232	.087	.053	.364				
	(.986)	**(.035)**	**(.037)**	(.404)	(.241)	(.048)	(.051)	(.781)	(.364)	(.111)	(.001)	(.020)	(.397)	(.606)	(.000)				
17 Finding A's Part 1	-.059	.013	.040	.007	-.008	-.038	-.054	-.103	.246	.291	.074	.203	.186	.057	.072	.149			
	(.558)	(.899)	(.693)	(.947)	(.935)	(.705)	(.598)	(.316)	(.013)	(.003)	(.462)	(.042)	(.069)	(.581)	(.474)	(.138)			
18 Finding A's Part 2	**-.241**	-.022	.147	.118	.032	.089	.076	-.029	.216	.230	.113	.111	.209	.007	-.009	.189	.572		
	(.016)	(.828)	(.144)	(.244)	(.749)	(.379)	(.462)	(.777)	(.030)	(.020)	(.259)	(.267)	(.041)	(.943)	(.930)	(.059)	(.000)		
19 Hidden Pattern Part 1	-.027	.079	.048	.032	.127	.102	.152	-.032	.224	.206	.209	.227	.219	.237	.153	.210	.233	.219	
	(.791)	(.438)	(.635)	(.755)	(.209)	(.314)	(.140)	(.759)	(.025)	(.040)	(.037)	(.023)	(.033)	(.021)	(.129)	(.036)	(.020)	(.028_	
20 Hidden Pattern Part 2	-.142	.011	.018	-.013	.133	.096	.224	.039	.129	.188	.206	.195	.278	.078	.168	.194	.192	.250	.715
	(.161)	(.918)	(.858)	(.896)	(.191)	(.343)	(.029)	(.709)	(.200)	(.061)	(.040)	(.052)	(.006)	(.451)	(.094)	(.053)	(.056)	(.012_	(.000)

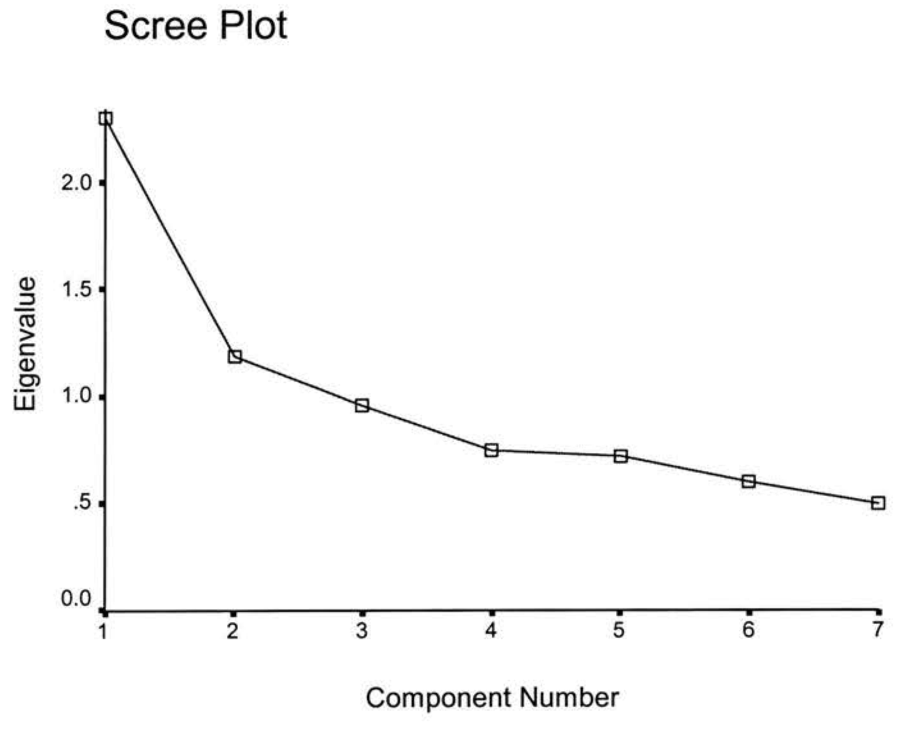

Figure 1
Scree slope of the principal components analysis of the total scores of the ability tests

Table 4
The first unrotated principal component analysis and the two oblique rotated factors for the 8 ability tests used in this study.

Name of Test	First Unrotated Principal Components Analysis	Oblique Rotated Factor 1 *	Oblique Rotated Factor 2 *
Vocab (2 tests combined)	.350	-.108	.821
Card Rotation	.663	.667	.079
Paper Folding	.698	.689	.103
Controlled Association	.576	.157	.783
Gestalt Completion	.543	.682	-.167
Finding A's	.533	.623	.086
Hidden Figures	.854	.491	.233

* Pattern Matrix, direct obliminal method

Nb. The two oblique rotated factors were unrelated ($\underline{r}$ = .203)

Appendix 6

Table 1
Spearman's correlations between the three ASSIST approaches and cognitive style. Correlations in bold are significant.

		1	2	3	4	5	6
1	Verbal-Imagery Ratio S1						
2	Verbal-Imagery Ratio S1	**.544** **(.000)**					
3	E-Wholistic-Analytic Ratio S1	-.078 (.441)	-.105 (.297)				
4	E-Wholistic-Analytic Ratio S2	-.047 (.640)	.083 (.414)	**.546** **(.000)**			
5	Deep Approach	.028 (.780)	.062 (.542)	-.051 (.615)	-.015 (.886)		
6	Strategic Approach	.008 (.938)	-.047 (.643)	.124 (.218)	.117 (.246)	**.201** **(.044)**	
7	Surface Approach	.052 (.607)	.025 (.804)	.048 (.637)	-.016 (.877)	**-.579** **(.000)**	-.091 (.366)

Table 2

Spearman's correlations between the ASSIST sub-scales and cognitive style. Underlined correlations are significant. Correlations in bold show the significant correlations between the ASSIST sub-scales and style

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Verbal-Imagery ratio S1																			
2	Verbal-Imagery ratio S2	**.544**																		
		(.000)																		
3	E-Wholistic-Analytic S1	-.078	-.105																	
		(.441)	(.297)																	
4	E-Wholistic-Analytic S2	-.047	.083	**.546**																
		(.640)	(.414)	**(.000)**																
5	Seeking Meaning	.012	-.033	-.024	-.067															
		(.907)	(.746)	(.816)	(.505)															
6	Relating Ideas	.031	.106	-.149	-.054	.553														
		(.756)	(.294)	(.139)	(.593)	(.000)														
7	Use of Evidence	.011	.062	.094	.116	.594	.600													
		(.910)	(.543)	(.353)	(.251)	(.000)	(.000)													
8	Deep Approach	.028	.062	-.051	-.015	.829	.860	.828												
		(.780)	(.542)	(.615)	(.886)	(.000)	(.000)	(.000)												
9	Interest in Ideas	-.050	.034	.133	.143	.306	.505	.500	.507											
		(.618)	(.737)	(.187)	(.155)	(.002)	(.000)	(.000)	(.000)											
10	Organised Studying	.043	.029	.043	.075	.210	.008	.171	.165	.238										
		(.673)	(.772)	(.668)	(.456)	(.035)	(.938)	(.087)	(.100)	(.017)										
11	Time Management	.000	-.009	.172	.119	.244	.013	.102	.148	.180	.728									
		(.999)	(.930)	(.087)	(.237)	(.014)	(.900)	(.310)	(.138)	(.072)	(.000)									
12	Alert to Assessmt Demands	-.075	-.181	.130	.092	.187	.005	.266	.168	.128	.345	.252								
		(.458)	(.072)	(.197)	(.362)	(.062)	(.962)	(.007)	(.093)	(.203)	(.000)	(.011)								
13	Strategic Approach	.008	-.047	.124	.117	.270	.023	.210	.201	.226	.887	.866	.597							
		(.938)	(.643)	(.218)	(.246)	(.006)	(.819)	(.035)	(.044)	(.023)	(.000)	(.000)	(.000)							
14	Achieving	-.115	-.047	.154	.151	.181	.020	.225	.176	.404	.654	.749	.432	.779						
		(.253)	(.642)	(.125)	(.134)	(.071)	(.839)	(.024)	(.078)	(.000)	(.000)	(.000)	(.000)	(.000)						
15	Monitoring effectiveness	-.051	-.140	.195	.065	.288	.094	.352	.279	.251	.482	.536	.408	.597	.522					
		(.616)	(.166)	(.052)	(.521)	(.003)	(.349)	(.000)	(.005)	(.011)	(.000)	(.000)	(.000)	(.000)	(.000)					

Table 2 continues

Table 2 continued

16	Lack of Purpose	.104	.137	-.135	-.166	-.175	-.228	-.187	-.232	-.439	-.207	-.189	-.159	-.222	-.358	-.219				
		(.301)	(.173)	(.182)	(.099)	(.080)	(.022)	(.062)	(.020)	(.000)	(.038)	(.058)	(.112)	(.026)	(.000)	(.028)				
17	Unrelated Memorising	.040	.015	**.267**	.093	-.384	-.459	-.448	-.506	-.300	.054	.006	-.131	-.027	-.108	-.030	.249			
		.(692)	(.886)	**(.007)**	(.356)	(.000)	(.000)	(.000)	(.000)	(.002)	(.590)	(.955)	(.191)	(.790)	(.284)	(.768)	(.012)			
18	Syllabus Bound	-.038	-.092	-.046	-.006	-.373	-.409	-.448	-.479	-.335	-.071	-.150	.152	-.058	-.244	-.192	.206	.233		
		(.707)	(.365)	(.650)	(.957)	(.000)	(.000)	(.000)	(.000)	(.001)	(.478)	(.134)	(.130)	(.566)	(.014)	(.055)	(.039)	(.019)		
19	Surface Approach	.052	.025	.048	-.016	-.451	-.516	-.515	-.579	-.514	-.052	-.116	-.034	-.091	-.286	-.167	.641	.689	.716	
		(.607)	(.804)	(.637)	(.877)	(.000)	(.000)	(.000)	(.000)	(.000)	(.605)	(.248)	(.738)	(.366)	(.004)	(.096)	(.000)	(.000)	(.000)	
20	Fear of Failure	-.153	-.106	**.229**	.049	-.157	-.237	-.078	-.221	-.102	.067	-.007	.081	.050	.035	.166	.024	.422	.138	.269
		(.128)	(.294)	**(.022)**	(.626)	(.117)	(.017)	(.440)	(.027)	(.312)	(.504)	(.941)	(.419)	(.621)	(.727)	(.098)	(.811)	(.000)	(.169)	(.007)

Appendix 7

Cognitive Styles Analysis Interpretation

Your Cognitive Style

An individual's cognitive style affects the manner in which information is processed during learning and thinking. It also influences the manner in which they respond to other people and social situations. Individuals vary in style from one extreme to another.

A cognitive style is different from intelligence in that an individual at one end of the continuum will be good at some tasks and poor at others, while for a person at the other extreme the situation will be the reverse.

The two fundamental dimensions of cognitive style assessed are the **Wholist-Analytic** mode of processing information and the **Verbal-Imagery** Style of the representation of information during thinking.

These two styles are independent of one another, that is the position of an individual on one dimension of cognitive style does not affect their position on the other. For instance a person may be a Wholist and an Imager and another an Analytic and an Imager, or another may be a Wholist and a Verbaliser, while someone else may be Analytic and a Verbaliser.

When Wholists consider information, they will have a balanced view of the whole, while Analytics will separate information out into its parts, or sections. *Intermediates* can do both.

How a wholistic or analytic style affects learning is shown below

Wholist	Analytic
1. Is able to see the whole.	1. Analyses material into parts.
2. Finds difficulty in disembedding.	2. Finds difficulty in seeing the whole.
3. Helped by making summaries and overviews first and then breaking information down into sections.	3. Helped by noting the key points and facts and linking them together to get the big picture.

When people who are Imagers read, listen to, or consider information they experience fluent, spontaneous and frequent mental pictures. By contrast, individuals who are Verbalisers read, listen to, or consider information in words. The Verbal Imagery mode of representation is a continuum with individuals placed along it. People in the middle *(Bimodals)* tend to use either mode of representation.

How a verbal or imagery cognitive style affects learning is shown below

Verbaliser	Imager
1. Learns best from verbal presentations.	1. Learns best from visual presentations.
2. Finds speech and text easier than diagrams.	2. Finds pictures easier than words.
3. Helped by writing notes, reading texts, reading aloud, and participating in group discussions.	3. Helped by making mind maps, using visualisation, peg words, and different colours.

Cognitive Styles Analysis Interpretation

Your Cognitive Style ....

What Cognitive Styles are

An individual's cognitive style affects the manner in which information is processed during learning and thinking. It also influences the manner in which they respond to other people and social situations. Individuals vary in style from one extreme to another.

What Cognitive Styles are not

A cognitive style is different from intelligence in that an individual at one end of the continuum will be good at some tasks and poor at others, while for a person at the other extreme the situation will be the reverse.

Types of Cognitive Style

The two fundamental dimensions of cognitive style assessed are the **Wholist-Analytic** mode of processing information and the **Verbal-Imagery** Style of the representation of information during thinking.

These two styles are independent of one another, that is the position of an individual on one dimension of cognitive style does not affect their position on the other. For instance a person may be a Wholist and an Imager and another an Analytic and an Imager, or another may be a Wholist and a Verbaliser, while someone else may be Analytic and a Verbaliser.

Wholist-Analytic Cognitive Style

What is a Wholistic - Analytic Style ?

When Wholists consider information, they will have a balanced view of the whole, while Analytics will separate information out into its parts, or sections. *Intermediates* can do both.

What effect does a Wholistic or Analytic Style have on learning?

Wholist	Analytic
1. Is able to see the whole.	1. Analyses material into parts
2. Finds difficulty in disembedding.	2. Finds difficulty in seeing the whole
3. Helped by making summaries and overviews first and then breaking information down into sections.	3. Helped by noting the key points and facts and then linking them together to get the big picture.

Verbal-Imagery Cognitive Style

What is a Verbal-Imagery Style ?

When people who are Imagers read, listen to, or consider information they experience fluent, spontaneous and frequent mental pictures. By contrast, individuals who are Verbalisers read, listen to, or consider information in words. The Verbal-Imagery mode of representation is a continuum with individuals placed along it. People in the middle *(Bimodals)* tend to use either mode of representation.

What effect does a Verbal or Imagery Style have on learning?

Verbaliser	Imager
1. Learns best from verbal presentations.	1. Learns best from visual presentation.
2. Finds speech and text easier than diagrams.	2. Finds pictures easier than words.
3. Helped by writing notes, reading texts, reading aloud, and participating in group discussions.	3. Helped by making mind maps, using visualisation, peg words, and different colours.

Cognitive Styles Analysis Interpretation

Your Cognitive Style

What Cognitive Styles are

An individual's cognitive style affects the manner in which information is processed during learning and thinking. It also influences the manner in which they respond to other people and social situations. Individuals vary in style from one extreme to another.

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A cognitive style is different from intelligence in that an individual at one end of the continuum will be good at some tasks and poor at others, while for a person at the other extreme the situation will be the reverse.

Types of Cognitive style

The two fundamental dimensions of cognitive style assessed are the **Wholist-Analytic** mode of processing information and the **Verbal-Imagery** style of the representation of information during thinking.

Wholistic

Analytic

Verbal

Imagery

These two styles are independent of one another, that is the position of an individual on one dimension of cognitive style does not affect their position on the other. For instance a person may be a Wholist and an Imager and another an Analytic and an Imager, or another may be a Wholist and a Verbaliser, while someone else may be Analytic and a Verbaliser.

Wholist Analytic Cognitive Style

What is Wholistic-Analytic Style ?

When Wholists consider information, they will have a balanced view of the whole, while Analytics will separate information out into its parts, or sections. *Intermediates* can do both.

What effect does a Wholistic or Analytic Style have on learning?

Wholist	Analytic
1. Is able to see the whole .	1. Analyses material into parts.
2. Finds difficulty in disembedding.	2. Finds difficulty in seeing the whole.
3. Helped by making summaries and overviews first and then breaking information down into sections.	3. Helped by noting the key points and facts and linking them together to get the big picture.

Verbal-Imagery Cognitive Style

What is a Verbal-Imagery Style ?

When people who are Imagers read, listen to, or consider information they experience fluent, spontaneous and frequent mental pictures. By contrast, individuals who are Verbalisers read, listen to, or consider information in words. The Verbal-Imagery mode of representation is a continuum with individuals placed along it. People in the middle *(Bimodals)* tend to use either mode of representation.

What effect does a Verbal or Imagery Style have on learning?

Verbaliser	Imager
1. Learns best from verbal presentations	1. Learns best from visual presentation
2. Finds speech and text easier than diagrams	2. Finds pictures easier than words
3. Helped by writing notes, reading texts, reading aloud, and participating in group discussions	3. Helped by making mind maps, using visualisation, peg words, and different colours

Appendix 8

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Personality and Individual Differences 33 (2002)

PERSONALITY AND INDIVIDUAL DIFFERENCES

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The reliability of Riding's Cognitive Style Analysis test

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Received 22 June 2001; received in revised form 11 January 2002; accepted 15 April 2002

Abstract

The reliability of Riding's popular Cognitive Styles Analysis test (CSA) was examined by comparing performance on the original CSA test and a new parallel version. Fifty participants completed both test versions twice, with the second sitting approximately a week later. Reliability was measured using parallel forms, test–re-test, and split-half analysis. Correlations of the verbal–imagery (VI) and wholist–analytic (WA) ratios from both test versions (original and parallel) were low (Range $r=0.07$ to $r=0.36$, Mean $r=0.24$). When the CSA and parallel form data were combined however, split-half analysis of the WA style ratio was stable (Mean $r=0.$ 69) but the VI style ratio remained unreliable (Mean $r=0.36$).

Keywords: Cognitive style; Reliability; CSA; Verbal; Imagery

Many tests have been devised in an attempt to discover whether an individual has a particular cognitive style, or a preferred way of processing information. One popular measure of cognitive style is Riding's (1991, 1998a) Cognitive Style Analysis (CSA) test, which claims to measure cognitive style on a verbal–imagery dimension and a wholist–analytic dimension.

Although a substantial amount of research has been conducted on the validity of the CSA (e.g. Riding & Agrell, 1997; Riding & Craig, 1999; Riding & Douglas, 1993; Riding, Glass, Butler, & Pleydell-Pearce, 1997), no research has been conducted on its stability and internal consistency. This study investigated the stability of the CSA, firstly by constructing a parallel version of the test (CSA-B) and secondly, by conducting test–re-test reliability examinations on the original (CSA-A) and parallel forms (CSA-B). The internal consistency was measured using split-half reliability analysis.

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PII: S0191-8869(02)00116-2

1. Method

1.1. Participants

Participants were 14 males and 36 females (age range 18–59; $M=27.6$, SD = 11.4). All participants were naïve as to the nature of the CSA test and the majority were undergraduate psychology students at the University of Edinburgh. All spoke English as their first language and the average level of education was high (education range = 10–24 years $M=16.9$, SD = 2.9).

1.2. Apparatus

Two E-PRIME computer programmes were created to present, control and record the temporal parameters of the two tasks. Task one (CSA-A) was an exact replica of Riding's (1991, 1998a) Cognitive Styles Analysis test except that no summary of the subject's results was presented on task completion. Task two (CSA-B) was designed to be a parallel version of Riding's CSA, again without the summary of the subject's results. Note that the original CSA computer programme was replicated to make the CSA-A because the original CSA did not allow the investigators to examine the subjects' errors and reaction times on each stimulus. Both the CSA-A and the CSA-B were presented on a Fujitsu Pentium Lifebook laptop computer.

1.3. Stimulus materials

A person's position on the verbal–imagery cognitive style dimension is obtained by computing the ratios of their reaction times to questions about semantic category and colour. The verbal–imagery stimuli consisted of 24 statements that required participants to compare the colour of two objects e.g., 'Are BLOOD and TOMATO the same colour?' and 24 statements that required participants to compare two objects conceptually e.g. 'Are CAR and VAN the same type?' Half the items were postulated to be the same and half the items different. The stimuli used in the CSA-A were exactly the same as Riding's (1991, 1998a) original CSA test. The CSA-A verbal–imagery stimuli were then matched for similarity and difficulty on the bases of a pre-pilot and pilot study (full details of these are available in Peterson, 2000). These matched stimuli were then used in the CSA-B.

A person's position on the wholist–analytic cognitive style dimension is obtained by computing the ratio of reaction times to questions about (1) shapes being identical and (2) a single shape being part of a complex figure. The wholist stimuli consisted of 20 examples of pairs of geometric figures made up of three basic geometric shapes (i.e. square, rectangle, and triangle). Participants were asked 'Is shape X the same as shape Y?' (see Fig. 1). In contrast, the analytic stimuli con-

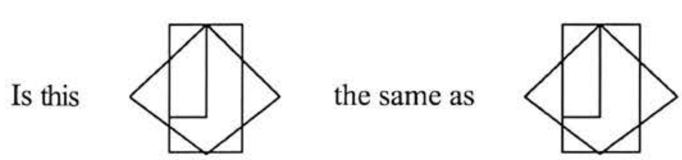

Fig. 1. Example of a wholist item on the CSA-B.

sisted of 20 examples of a single geometric shape next to a complex shape (made up of three geometric shapes). Participants were asked 'Is shape X contained in shape Y?' (see Fig. 2). Half the items were the same shape or embedded in the more complex figure and half of the shapes were not. The wholist–analytic stimuli used in the CSA-A were exactly the same as Riding's (1991, 1998a) original test. The CSA-B used the same core geometric shapes as the original CSA. The only exception was that the CSA-B did not employ an 'L' shape.

1.4. Design

In studying the reliability of a psychological measure it is appropriate to power the study to detect coefficients in excess of about 0.5. Coefficients below that would indicate poor reliability. Thus with alpha set at 0.05 (2 tailed) and with $r=0.5$, this study had a power of 0.96. Adequate power is usually considered to be 80% or above. Indeed the study had 82% power to detect an effect size of 0.4.

A 2×2×2 (test version, session, order) mixed model analysis of variance (ANOVA) was performed on the subjects' mean and median response times on each test section (verbal, imagery, wholist, and analytic). Test version (CSA-A, CSA-B), and session (1, 2) were within subjects variables and test order (CSA-A-CSA-B, CSA-B-CSA-A) was a between subject variable. Irrespective of whether the dependent variable was the mean or the median reaction time, the results were largely the same. The data was also log transformed to adjust for a positive skew on each section of the test and the ANOVAs were recalculated, producing similar results. Only the results from the untransformed mean data will be discussed. An alpha level of 0.05 was used for all statistical tests.

The order of the test sections (verbal, imagery, wholist, analytic) for both the CSA-A and the CSA-B were also kept the same as the original CSA test. The presentations of CSA-A and CSA-B tests were counterbalanced across subjects and sessions.

1.5. Procedure

Participants were tested individually in a quiet relaxed environment. All participants were given the same instructions and followed the same basic procedure as set out in the Cognitive Styles Analysis Administration manual (Riding, 1991/1998a). A session involved completing both the CSA-A and the CSA-B with a 5-min break between each test. All participants repeated the CSA-A and the CSA-B no less than 6 days later ($M=8.5$, $SD=10.6$ days). No feedback was given to the subjects on their performance until after they had completed the second session.

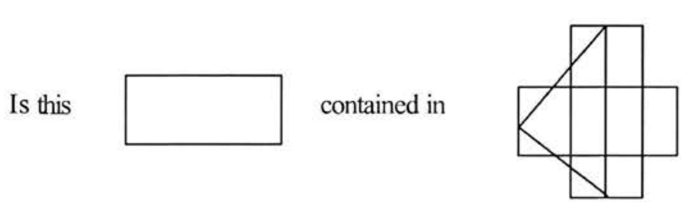

Fig. 2. Example of an analytic item on the CSA-B.

2. Results

Responses to each stimulus were classified as either correct or error. Scores (total correct) and reaction times (ms) were recorded for each participant, on each test version (CSA-A, CSA-B), section (verbal, imagery, wholist, analytic) and session (1, 2).

2.1. Similarity between the responses on the CSA-A and the CSA-B

The CSA-A and the CSA-B had similar mean and median reaction times and similar standard deviations within each test section and session. Furthermore, the correlations between the CSA-A and the CSA-B median reaction times on each section were high, ranging from $r=0.55$, $P<0.001$ to $r=0.87$, Mean $r=0.74$, $P<0.001$. Overall error rates were found to be low, with 97% of responses on the CSA-A and 96% on the CSA-B being correct.

Main effects were found for the experiment version (CSA-A, CSA-B) in the verbal (F [1, 48]$=4.21$, $P=0.046$) and imagery sections (F [1, 48]$=5.32$, $P=0.025$). These effects reflect the slightly faster CSA-A verbal and CSA-A imagery response times compared to the CSA-B. A main effect was also found for session on each test section (all P's<0.001) with performance at session 2 being faster than performance at session 1.

Significant interactions were found between test version (CSA-A, CSA-B) and the order of tests presentation (i.e. CSA-A-CSA-B or CSA-B- CSA-A) (all P's<0.001). This interaction reflected the fact that the test taken second resulted in the faster response times irrespective of the order. Similarly, a three-way interaction was also found between the experiment, session and order for each section of the test (all P's<0.001). This also appears to have resulted from a practice effect. Detailed accounts of these and other effects may be found in Peterson (2000).

Overall, these results indicate that the CSA-A and the CSA-B have similar reaction times, error rates, and thus behave in similar ways. Therefore, the CSA-B may be treated as a suitable parallel test for the CSA-A.

2.2. Allocation of cognitive style

Riding's (1991, 1998a) CSA determines a person's cognitive style by using the three-step formula. Step 1: Calculate the average response time on each section of the CSA test (verbal, imagery, wholist, and analytic). Step 2: Calculate 2 ratios. The first ratio between the average reaction times on the verbal and imagery items and the second between the average reaction times on the wholist and analytic items. Step 3: Associate the value of each subject's verbal–imagery ratio and wholist–analytic ratio with a style category. Note that Riding (1998b) suggests that research groups can allocate style category in two main ways: (1) divide the sample into three groups on each dimension; or (2) compare the ratios with a standardised sample comprising of 999 people in the UK (Riding, 1991/1998a).

2.3. Stability of the CSA-A and the CSA-B

In order to examine how reliable and stable this procedure of style allocation was, correlations between each subject's performance on the two test versions (CSA-A, CSA-B) and two sessions

(1, 2), at each of the three steps were calculated (see Table 1). Kline (2000) suggested that a reliability of about 0.7 is the minimum requirement for a good test.

Table 1 shows that the correlations at step 1 between each subject's median reaction times on each version of the test (i.e. between the CSA-A and the CSA-B) were high (Mean $r=0.72$; Range $r=0.55$ to $r=0.87$). It was therefore concluded that the initial reaction times were reliable and stable between the original and parallel versions of the test. Correlations between the median reaction times on each session (i.e. between session 1 and session 2) of the test were also high (Mean $r=0.72$; Range $r=0.61$ to $r=0.86$) suggesting that initial individual differences in reaction times on the CSA-A and the CSA-B are stable at re-test.

The correlations between test versions and sessions for the verbal–imagery and wholist–analytic ratios at step 2 and labels at step 3 were computed next (see Table 1). The strongest correlations in step 2 and 3 tended to be on the wholist–analytic dimension with the majority of correlations around $r=0.2$ or $r=0.3$. The verbal–imagery ratios were lower and around $r=0.1$ or $r=0.2$.

Note that the correlations at step 2 and 3, between the CSA-A and CSA-B ratios and style labels, were low despite the fact that the participants in the study represented a full range of cognitive styles at both session 1 and session 2 (see table 2). Furthermore, the mean of the ratios for each dimension (Verbal–Imagery $M=1.0$, SD=0.20; Wholist–Analytic $M=1.2$, SD=0.33) were also found to be similar to Riding's (1991, 1998a) Secondary School Standardisation Sample (Verbal–Imagery $M=1.6$, SD=0.20; Wholist–Analytic $M=1.25$, SD=0.45). Therefore, there

Table 1
Table of correlations for session 1 (S1) vs session 2 (S2) and for the CSA-A vs CSA-B, on each section and session of the tests

	Medians (*P*)	Dimension VI and WA	Ratios (*P*)	Labels (*P*)
*CSA-A vs CSA-B (*N=*50)*				
Verbal, CSA-A vs CSA-B, S1	0.581 (0.000)			
Verbal, CSA-A vs CSA-B, S2	0.766 (0.000)			
Imagery, CSA-A vs CSA-B, S1	0.623 (0.000)	VI, CSA-A vs CSA-B, S1	0.175 (0.223)	0.139 (0.227)
Imagery, CSA-A vs CSA-B, S2	0.779 (0.000)	VI, CSA-A vs CSA-B, S2	0.358 (0.011)	0.256 (0.046)
Wholist, CSA-A vs CSA-B, S1	0.546 (0.000)			
Wholist, CSA-A vs CSA-B, S2	0.866 (0.000)			
Analytic, CSA-A vs CSA-B, S1	0.710 (0.000)	WA, CSA-A vs CSA-B, S1	0.074 (0.609)	0.146 (0.304)
Analytic, CSA-A vs CSA-B, S2	0.873 (0.000)	WA, CSA-A vs CSA-B, S2	0.301 (0.034)	0.301 (0.034)
*Session 1 vs Session 2 (*N=*50)*				
Verbal, CSA-A, S1 vs S2	0.611 (0.000)			
Verbal, CSA-B, S1 vs S2	0.712 (0.000)			
Imagery, CSA-A, S1 vs S2	0.705 (0.000)	VI CSA-A, S1 vs S2	0.201 (0.161)	0.100 (0.437)
Imagery, CSA-B, S1 vs S2	0.624 (0.000)	VI CSA-B, S1 vs S2	0.202 (0.159)	0.145 (0.254)
Wholist, CSA-A, S1 vs S2	0.731 (0.000)			
Wholist, CSA-B, S1 vs S2	0.735 (0.000)			
Analytic, CSA-A, S1 vs S2	0.817 (0.000)	WA, CSA-A, S1 vs S2	0.297 (0.036)	0.341 (0.017)
Analytic, CSA-B, S1 vs S2	0.861 (0.000)	WA, CSA-B, S1 vs S2	0.310 (0.028)	0.225 (0.110)

Medians = correlations between the medians; Dimensions = correlations between the dimensions; VI = verbal imagery dimension; WA = wholist–analytic dimension; Ratios = correlations between the ratios; Labels = correlations between the labels.

was a full and representative range of individual differences in the way subjects responded to the verbal–imagery and wholist–analytic dimensions, but these differences were not stable.

In summary, the CSA-A and CSA-B results show that initial reaction times are stable and reliable but the style ratios and style labels have low parallel form and test–re-test reliabilities. The wholist–analytic ratio did however remain more stable than the verbal–imagery ratio.

2.4. Internal consistency of the CSA-A and the CSA-B

To examine whether the CSA-A and the CSA-B were internally consistent, responses on even and odd items on each section of the test were split creating two halves (odd, even) and then re-analysed. The median reaction times on each half of the split data were not significantly different for any test versions, test sections and test sessions. Table 3 shows the correlations between each half of the split data for each test version and session, at each of the three steps of style calculation. Overall the correlations on the split data were slightly higher than the correlations on the unsplit data (compare Tables 1 and 3). Reliabilities of raw reaction times are very high. Reliabilities of ratios and labels are much less. The wholist–analytic dimension continued to be more stable than the verbal–imagery dimension with stability as high as $r=0.6$.

2.5. Stability and internal consistency of the combined CSA-A and CSA-B data

To address Riding's (1991/1998a) concern that there may be insufficient items to examine the CSA's stability and internal consistency and still get a reliable result, each subject's data from the CSA-A was combined with their data from the CSA-B to form a double-sized, or combined CSA test (C-CSA). Therefore, the C-CSA had a larger number of items on which to base the cognitive style calculations for each subject. The combined data was firstly re-analysed to examine stability between test sessions and secondly, it was split to examine internal consistency within each test session (see Table 4).

Table 4 shows that the stability and the internal consistency of the combined data are higher at each step of style calculation than the stability and internal consistency of the CSA-A or the CSA-B alone (compare Tables 1 and 3 with Table 4). Although the combined data also show the familiar pattern of falling correlations with each subsequent style calculation, the correlations

Table 2
Table of style label frequency at session 1 and session 2 based on Riding's (1991/1998a) standardised norms

Dimension	Session 1 frequency	Session 2 frequency
Verbal–Imagery dimension		
Verbal	39	37
Bimodal	29	40
Imagery	32	23
Wholist–Analytic dimension		
Wholistic–Analytic	19	28
Intermediate	58	60
Analytic	23	12

only show a substantial drop on the verbal–imagery dimension. Indeed, the most important finding of this study was that the split half reliability of the wholist–analytic ratio from the C-CSA approached a satisfactory level of $r = 0.7$, and this was repeated at a second sitting.

3. Discussion

The results presented above suggest that the CSA-A and the CSA-B were suitable parallel tests as both tests generated similar error rates and average reaction times. Furthermore, the subjects' average reaction times were highly correlated between the two test versions and over time. Despite the fact the CSA-A and the CSA-B can be considered parallel tests, the results suggest that the CSA-A and the CSA-B in their current form are not stable or internally consistent measures of cognitive style preference. The CSA is however not a redundant test because when the CSA-A is combined with the CSA-B, to make a longer test with more items, the split half reliability of cognitive style preferences on the wholist–analytic dimension approaches a reliability of $r = 0.7$. In other words, the extended wholist–analytic dimension of cognitive style preference meets the reliability criteria for a psychometric test, but the verbal–imagery dimension of style preference does not.

More specifically, analyses of all the reliability results on the CSA-A and CSA-B alone revealed a persistent pattern. The initial session 1 versus session 2 and CSA-A versus CSA-B median reaction times were all highly correlated within each task section (verbal, imagery, wholist, ana-

Table 3
Table of correlations for odd vs even items at each section and session (S1, S2) and on each test version ($N = 50$)

	Medians (*P*)	Dimension VI and WA	Ratio (*P*)	Labels (*P*)
Verbal, CSA-A, S1, odd vs even	0.869 (0.000)			
Verbal, CSA-A, S2, odd vs even	0.873 (0.000)			
Verbal, CSA-B, S1, odd vs even	0.845 (0.000)			
Verbal, CSA-B, S2, odd vs even	0.896 (0.000)			
Imagery, CSA-A, S1, odd vs even	0.839 (0.000)	VI CSA-A, S1, odd vs even	0.314 (0.026)	0.274 (0.036)
Imagery, CSA-A, S2, odd vs even	0.848 (0.000)	VI CSA-A, S2, odd vs even	0.048 (0.741)	0.094 (0.468)
Imagery, CSA-B, S1, odd vs even	0.876 (0.000)	VI CSA-B, S1, odd vs even	0.213 (0.138)	0.209 (0.104)
Imagery, CSA-B, S2, odd vs even	0.825 (0.000)	VI CSA-B, S2, odd vs even	0.132 (0.361)	0.106 (0.405)
Wholist, CSA-A, S1, odd vs even	0.956 (0.000)			
Wholist, CSA-A, S2, odd vs even	0.914 (0.000)			
Wholist, CSA-B, S1, odd vs even	0.926 (0.000)			
Wholist, CSA-B, S2, odd vs even	0.905 (0.000)			
Analytic, CSA-A, S1, odd vs even	0.832 (0.000)	WA CSA-A, S1, odd vs even	0.620 (0.000)	0.537 (0.000)
Analytic, CSA-A, S2, odd vs even	0.900 (0.000)	WA CSA-A, S2, odd vs even	0.482 (0.000)	0.482 (0.000)
Analytic, CSA-B, S1, odd vs even	0.928 (0.000)	WA CSA-B, S1, odd vs even	0.559 (0.000)	0.497 (0.000)
Analytic, CSA-B, S2, odd vs even	0.928 (0.000)	WA CSA-B, S2, odd vs even	0.523 (0.000)	0.440 (0.001)

Means = correlations between the medians; Dimensions = correlations between the dimensions; VI = verbal–imagery dimension; WA = wholist–analytic dimension; Ratios = correlations between the ratios; Labels = correlations between the labels.

lytic) suggesting stability and internal consistency. However, as the cognitive style preference ratios were calculated for each dimension, and the style labels allocated, the correlations fell below what is acceptable for a psychometric test.

Therefore, the most encouraging result of the present study is that wholist–analytic style ratios based on the combined (CSA-A-CSA-B) data approached a split-half reliability of $r=0.7$. Since the ratios are approximately normally distributed, there is no good statistical reason to allocate people further into categories. Therefore, by using the CSA-A and the CSA-B people can reliably be categorised on the wholist–analytic dimension.

3.1. Verbal–imagery dimension—why was it unreliable?

The results of this study clearly show that the verbal–imagery dimension of the CSA-A and CSA-B is less stable than the wholist–analytic dimension. The reasons for its instability are unclear. It is possible that responding on the verbal–imagery dimension is more varied because the verbal–imagery dimension questions ('Are 'X' and 'Y' the same Colour?' or 'Are 'X' and 'Y' the same type?) are more subjective than the wholist–analytic dimension questions (see Figs. 1 and 2). It is also possible that the individual differences in verbal–imagery processing are not as prevalent as the individual differences in the wholist–analytic dimension. Indeed, it is interesting to note that compared to the wholist–analytic dimension there has been little empirical investigation into the possibility of their being a competing verbal–imagery dimension. Several tests of the verbal–imagery dimension have been proposed (e.g. Richardson's Verbaliser-Imager, 1977; Riding & Taylor's Verbalizer-Imagery, 1976) but the evidence for it is less substantial than the

Table 4
Table of correlations for C-CSA session 1 (S1) vs session 2 (S2) and C-CSA odd vs even items at each section and session ($N=50$)

	Medians (*P*)	Dimension VI and WA	Ratio (*P*)	Labels (*P*)
C-CSA, S1 vs C-CSA, S2				
Verbal, C-CSA, S1 vs S2	0.823 (0.000)			
Imagery, C-CSA, S1 vs S2	0.846 (0.000)	VI C-CSA S1 vs S2	0.266 (0.061)	0.205 (0.111)
Wholist, C-CSA, S1 vs S2	0.877 (0.000)			
Wholist, C-CSA, S1 vs S2	0.925 (0.000)	WA C-CSA S1 vs S2	0.532 (0.000)	0.381 (0.005)
C-CSA, Odds vs C-CSA, Evens				
Verbal, C-CSA, S1, odd vs even	0.869 (0.000)			
Verbal, C-CSA, S2, odd vs even	0.959 (0.000)			
Imagery, C-CSA, S1, odd vs even	0.916 (0.000)	VI C-CSA S1, odd vs even	0.292 (0.039)	0.245 (0.056)
Imagery, C-CSA, S2, odd vs even	0.924 (0.000)	VI C-CSA, S2, odd vs even	0.422 (0.022)	0.215 (0.091)
Wholist, C-CSA, S1, odd vs even	0.954 (0.000)			
Wholist, C-CSA, S2, odd vs even	0.971 (0.000)			
Analytic, C-CSA, S1, odd vs even	0.933 (0.000)	WA CSA-A, S1, odd vs even	0.685 (0.000)	0.512 (0.000)
Analytic, C-CSA, S2, odd vs even	0.956 (0.000)	WA CSA-A, S2, odd vs even	0.693 (0.000)	0.518 (0.000)

Means = correlations between the medians; Dimensions = correlations between the dimensions; VI = verbal–imagery dimension; WA = wholist–analytic dimension; Ratios = correlations between the ratios; Labels = correlations between the labels.

evidence for the wholist–analytic dimension which has been investigated under various guises since the late 1940s (e.g. Field Dependence-Independence, Witkin & Asch, 1948a, 1948b; Levellers and Sharpeners, Holzman & Klein, 1954; Impulsivity and Reflectivity, Kagan, Rosman, Day, Albert, & Philips, 1964; Divergent-Convergent Thinking, Guilford, 1967; Holist Serialists, Pask & Scott, 1972 etc.). More research into why the verbal–imagery dimension of cognitive style is less stable than the wholist–analytic dimension is needed.

3.2. Why did the correlations fall: the use of the ratio

The results also show a consistent pattern of falling correlations with each subsequent step of the cognitive style calculation. This may in part be due to the use of a ratio to determine an individual's style preference. The problem is that even if the measure of performance on each section of the CSA test (verbal, imagery, wholist and analytic) was stable, the process of defining an individual's style category by dividing an individual verbal score by their imagery score and their wholist score by their analytic score decreases stability. This is because any measure that is computed as a difference between other measures is less reliable than a single measure (Lohman, 1999). In this way, it is possible that the lower reliability of the style ratios, which are then used to determine style category, may to some extent underlie the subsequent lack of reliability of style category allocation.

3.3. Potential limitations of the study

The test-re-test interval in this study was small ($M = 8.5$ days). Riding (1991/1998a) suggested that a test-re-test interval of approximately a year is needed because subjects may remember the questions on a second sitting and therefore may respond faster at session 2. Indeed the results indicated that there was a practice effect with session 2 performance being faster than session 1. However, to determine cognitive style preference, the CSA constructs a verbal–imagery ratio and a wholist–analytic ratio, and provided that the participants at session 2 respond faster on all sections of the task (verbal, imagery, wholist and analytic), then the ratio of verbal to imagery and wholist to analytic responses will not change between session 1 and session 2. Furthermore, if style has 'temporal stability' (Riding & Rayner, 1998) then a within-subjects comparison should also have no time-based effects. Nevertheless, to avoid the potential criticism that practice may have affected our results, the current study also constructed a parallel test. Subject performance on the original and parallel test was then compared to check for stability. The results showed that the correlations between the style preference ratios and style labels on the original and parallel forms were still below the acceptable level for a psychometric test (see Table 1).

Riding (1991/1998a) also suggests that doubling the length of the CSA may make it too long for a subject to do without fatigue. The current experiment allowed 5 minutes between the sitting of CSA-A and the CSA-B and hence it could be argued that the testing session was too long and the break between test versions too short. However, there is no evidence in the literature to suggest that the current length of the CSA is the only one that will get an effect. Nevertheless, to counteract any potential criticism, this study counterbalanced the presentation of the CSA-A and the CSA-B. In other words, if the CSA-A was sat first at session 1, it was sat second at session 2 and vice versa. This allowed the investigators to compare performance on the original and parallel tests that were sat first either at each session 1 or at session 2 and therefore no learning and no fatigue should have occurred. The results showed that even when performance was compared between the tests sat first at each session, the stability was below acceptable levels for a psychometric test. In addition, the results clearly indicate that when the subjects' performance on the CSA-A and the CSA-B was combined, the correlations between session 1 and session 2 performance went up. Indeed by combining the CSA-A and CSA-B, the wholist–analytic dimension became stable. Thus, contrary to the suggestion of fatigue, the longer test improves stability.

A potential criticism of the parallel test was that some elements of item used on the verbal imagery section of the parallel test were also used on the original test. This was primarily because pilot studies had shown that it was very difficult to find objects that were associated with only one colour and hence could be used for the imagery question 'Are X and Y the same colour?' However, the item elements that were reused always appeared in novel pairs and hence the items (word pairs) on the parallel test required a different conceptualisation from the original CSA. It is therefore unlikely that the repeated words significantly affected the results.

In conclusion, the findings of this study suggest that the CSA measure of the verbal–imagery and wholist–analytic cognitive style preference in its current form is not reliable or internally consistent. If the CSA is doubled in length then the wholist–analytic dimension of cognitive style preference becomes a more stable and reliable measure.

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Personality and Individual Differences 33 (2002) 1–6

PERSONALITY AND INDIVIDUAL DIFFERENCES

www.elsevier.com/locate/paid

On the assessment of cognitive style: four red herrings

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Received 28 February 2002; received in revised form 19 March 2002; accepted 15 April 2002

Abstract

This paper is a reply to Riding's (2002) four main comments on Peterson, Deary, and Austin's (2002) paper 'The Reliability of Riding's Cognitive Style Analysis Test.' Riding's comments centre around Peterson et al.'s sample size, sample composition, test interval, and the alleged use of a different test from the original. We argue that the first three of these comments are incorrect and the fourth is disingenuous and that they merely distract from, rather than criticise, our simple, novel, positive finding that the reliability of the wholistic–analytic dimension of the Cognitive Styles Analysis (CSA) test can be improved. © 2002 Elsevier Science Ltd. All rights reserved.

Riding (2002) makes four main comments on our paper 'The Reliability of Riding's Cognitive Styles Analysis Test' (Peterson et al., 2002). These are as follows:

> "[1] the use of a rather small and [2] perhaps atypical sample, [3] the choice of a relatively short interval between testing, and [4] the use of, in effect, a different form of assessment from (sic) the one it claims to test, are the significant problems. Consequentially the study is not a reliability test of the CSA" (Riding, 2002, numbers added)

These four issues are red herrings. We now explain why they should not distract from or obscure our simple and novel finding: that the ratio of the wholistic–analytic dimension of the CSA when doubled in length is moderately reliable, whereas, the verbal–imagery dimension ratio is not. Riding's other, more minor comments are addressed and are also found to be distractions from, rather than criticisms of, our straightforward findings.

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PII: S0191-8869(02)00118-6

1. 'Use of a rather small...sample'

This comment is incorrect. The sample size employed in our study ($N = 50$) was adequate: it was carefully chosen using power analysis before the experiment began. Given that we were studying the reliability of a psychological measure it was appropriate to power the study to detect correlation coefficients in excess of about 0.5. Coefficients below that would indicate unacceptably poor reliability, and so it was not necessary to test a larger number, especially with the workload involved in re-testing subjects at least a week apart. Thus with alpha set at 0.05 (2 tailed) and with $r = 0.5$, the study had a power of 0.96! Adequate power is usually considered to be 80% or above. Indeed, the study had 82% power to detect a smaller effect size of 0.4, which is far below that considered adequate for reliability.

2. 'Atypical sample'

This comment is incorrect: our sample was not atypical with respect to cognitive styles. Our sample demonstrated the full range of cognitive styles at both session 1 and session 2, and we have also shown that the means of our style ratios were very similar to Riding's (1998) Secondary School Standardisation Sample. In addition, Riding clearly states that the CSA is "not a test of intelligence or ability" (Riding, 1991, 1998a, p. 4) and therefore our sample, of naïve volunteer students should not have adversely affected the reliability results on the variables of interest. Furthermore, the use of a largely student-based sample is in keeping with several other studies (mostly by Riding) that have used the CSA (e.g., Riding & Staley, 1998; Riding & Wigley, 1997; Sadler-Smith, 2001; Sadler-Smith & Riding, 1999).

3. The short test re-test interval

This comment is arbitrary and ignores the fact that test–retest reliability was only one of the types of reliability that we tested here: we also examined parallel form and split-half reliability. Furthermore, there is nothing in cognitive styles theory to indicate that individual differences in style measures should not show stability across the period used here. We acknowledged in our paper that the mean test re-test interval was short, and that the there was a practice effect, with session 2 performance being faster than session 1. However, we also outlined several reasons why we do not believe that the short test interval was a problem. Firstly, if styles have 'temporal stability,' which Riding and Rayner (1998, p. 6) and others propose that they do, then a within-subjects comparison should have no time-based effect other than a practice effect which should not affect the style ratios. Secondly, to determine cognitive style preference the CSA constructs a verbal–imagery ratio and a wholistic–analytic ratio and, provided that the participants at session 2 respond faster on all sections of the task, which the results suggest they did, then the ratio of verbal to imagery and wholistic to analytic responses will not change between session 1 and session 2. Nevertheless, to avoid claims that practice may affect the reliability calculation, we also constructed and tested all subjects on a parallel test and examined the split-half reliability of each test. Correlations between the subject's style ratios and style labels on the original and parallel test, were then compared to check for stability and found to be below acceptable levels for psychometric tests ($r < 0.36$). The correlations between the split-half ratios of each test were found to be unacceptable for the verbal–imagery dimension (mean $r = 0.176$) and marginal for the wholistic–analytic dimension (mean $r = 0.546$). The split-half reliability was however greatly improved on the wholistic–analytic dimension when the test was doubled in length ($r = 0.69$). In any event, it is open to other researchers to examine different test re-test periods to discover whether there are systematic differences in stability as a function of time.

4. Supposed difference between the original CSA and the CSA-A and CSA-B

4.1. The CSA-A is not a replica of the CSA

This comment is disingenuous. We argue that the only difference between the CSA and the CSA-A is that the CSA presents a summary of the results on task completion but this is removed on the CSA-A, so that the subjects are naïve as to their imputed cognitive style at re-test. All other screen presentations were exactly the same in terms of colour, font, style and timing. Indeed, for the wholistic–analytic dimension, which presents complex shapes to which the subjects have to respond, we went to the extent of saving all the shapes as bitmap files and these bitmaps were then presented on the CSA-A. Therefore, the exact same shape proportions were also used for the wholistic and analytic sub tests of the CSA-A. This procedure was not necessary for the verbal–imagery sub test of the CSA-A, which is presented in words and therefore is easier to copy exactly.

We agree with Riding that ideally a reliability study 'requires the use without modification of the test of which it claims to assess the reliability'. However, if we could have avoided precisely replicating the CSA we should have gladly done so. The problem was we needed to replicate the CSA in order to access each individual's reaction time and accuracy to each item. The CSA provided by Riding only gives a mere summary of the results: it calculates the overall percentage of errors and calculates style based upon the ratio of reaction time to certain types of items. The CSA program does not allow access to the raw reaction times or item accuracy. Thus it is not useable by psychometric researchers as they cannot compute the style ratios themselves, measure variance, or examine the items that incur high error rates. Therefore, constructing an exact replica of the CSA was the only way we could precisely measure accuracy and reaction time. In summary: the commercially available CSA does not afford the opportunity for psychometric research by independent investigations; and our version did not otherwise appreciably differ from the original.

4.2. 'The effective length of the test was doubled' (p. 2)

This comment is arbitrary—if anything the doubling is an advantage. Riding raised the concern that the test length was effectively doubled by administering the CSA-A and following it with the CSA-B five minutes later. The most surprising aspect of this comment is that Riding is ignoring the fact that one dimension of the CSA *does* show better reliability when the test is doubled. Furthermore, we believe that it is highly unlikely that the arbitrary length of the initial CSA test is the only way to measure cognitive style. Nevertheless, we have also shown that, when performance on test 1 at session 1 was compared with test 1 at session 2, and, therefore, an analysis was conducted when no fatigue could have set in and the test length was the same, the reliability of the critical style ratio was still below acceptable psychometric test levels ($r < 0.18$). In addition, the counterbalancing of the subject's performance on the two tests meant that the first test that each subject sat at each session was different and therefore no learning and no fatigue could have set in within a test session.

4.3. *'It appears likely that the CSA(A) and CSA(B) calculated the verbal–imagery ratio in a different manner from the CSA'*

This comment is unclear but does not alter the fact that our calculations were correct and appropriate. Riding raises two concerns about the calculation of the verbal–imagery ratio. The first is that we may not have made a distinction 'between the two types of negative items used in the Verbal-Imagery sub test'. We are not sure what Riding means by this statement. The CSA-B uses exactly the same proportion of negative and positive items as the CSA and the order in which positive and negative items were presented was also kept the same. Riding's second concern was that we might not have used these negative items correctly when calculating the verbal–imagery style ratio. Riding's (1991, 1998a) CSA test manuals, which accompany the CSA test package, make no reference to the different treatment of negative items in the calculation of the verbal–imagery style ratio. Therefore, we do not see any need to alter our calculations. Our calculation of the style ratios is entirely appropriate for the task and *our* method of calculation is transparent and valid.

4.4. *Treatment of the split-half reliability analysis*

This comment is irrelevant. Riding raises the concern that the split-half reliability of the WA and VI dimensions may not have taken account of the 'same'/'different' items. Riding suggests that this may have been problematic because the 'same' items might be judged more quickly than the 'different' items. We agree that it is possible that the individual mean response times are faster for 'same' items. However, when we randomly re-split the data the correlations remained almost exactly the same as the correlations between the items that were split into odds and evens. Therefore, taking specific account of the 'same'/ 'different' items would not alter our results. Furthermore, reliability is about correlations, not absolute values, so, if the test is reliable, people who have a style which causes them to answer 'same' items quickly relative to the group as a whole, should also answer 'different' items relatively quickly. Therefore, it may well be that individual mean response times are faster for 'same' items but this does not invalidate the correlation used to assess reliability.

5. Other potential concerns

5.1. *The use of the ratio*

Riding states that 'A ratio is used to overcome the problem of distinguishing style from intelligence or ability'. We are fully aware that the advantage of the ratio is that it does allow cognitive styles to be more easily compared, and it does help to separate style from intelligence. What we are communicating is that the use of the ratio also has disadvantages because any measure that is computed as a difference between other measures is less reliable than a single measure (Lohman, 1999). In this way, it is possible that the lower reliability of the style ratios, which are then used to determine style category, may contribute to the subsequent lack of reliability of style category allocation. Our doubling of the task length improved the reliability of the ratio. There was no need to defend the use of the ratio. It is a good idea. However, it suffers a statistical handicap that needs addressing.

5.2. Repeated Items

Riding also expresses concern over the fact that some verbal–imagery stimuli words used on the CSA-A were also used on the CSA-B. More specifically the verbal–imagery sub test of the CSA presents subjects with stimuli that consist of a pair of words (e.g. 'bread' and 'butter'). Subjects are asked to judge whether these two objects presented in the stimuli are the same colour or type. The CSA-B did use some of the same words as the original CSA however, the pairings were always novel and hence there was no replication of the CSA stimuli. In other words, the items that were reused on the parallel test required a different conceptualisation from the original CSA. It is therefore very unlikely that the repeated words significantly affected the results. The reason elements of the pairs were used twice was that pilot studies had found it difficult to find objects that were associated with only one colour and hence could be used for the imagery question 'Are X and Y the same colour?'

5.3. Counterbalancing

Riding raises the concern that the counterbalancing of the order of presentation at test and re-test 'means that only 25 subjects had the CSA(A)—the one which was intended to be like, and directly comparable with, the CSA-first on both occasions'. This is not correct. The counter-balancing of the CSA-A and CSA-B was done between subjects and between sessions. In other words, if subject A sat the CSA-A first at session 1, then they would sit the CSA-B first at session 2. Subject B would then sit the CSA-B first at session 1 and the CSA-A first at session 2 etc. Therefore, no subjects sat the CSA-A first at both session 1 and session 2. Although Riding raises this as a concern we believe that, because the CSA-B is a wholly parallel test (and the results entirely support this), it was not necessary to have subjects sit the CSA-A first at both session 1 and session 2. Indeed, if we had not counterbalanced the presentation of the tests then we would have been unable to control for potential effects of test order on performance.

5.4. Validity

Riding also suggests that reliability is not the most important characteristic of a test and he goes on to note that the CSA reliability should be seen within the context of the CSA validity. The purpose of our paper was to review the CSA's reliability, which is an important aspect of the test that has not been explicitly explored in the literature. In contrast, the validity of the CSA has already been substantially addressed elsewhere (see Riding & Rayner, 1998, for a review).

In conclusion, our study showed that when the CSA's test of the wholistic–analytic dimension is doubled in length, it becomes quite a reliable measure. However, the verbal–imagery dimension of the CSA remains unstable both in its original form and when it is doubled in length. We have shown that, despite Riding's concerns, our sample was well-powered to investigate these trends, and that the sample was appropriate, consisting of subjects with a range of cognitive styles similar to that of the Standardised Secondary School Sample. The CSA-A and the CSA-B were appropriate tests to examine the reliability and internal consistency of the CSA. Having shown that these four comments and his more minor concerns are distractions from our clear results, we conclude the opposite of Riding and claim that our 'study *is*... a reliability test of the CSA'. By distracting from our main finding that it is possible, indeed simple, to improve the reliability of one aspect of the CSA we think Riding is looking a gift horse in the mouth.

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