

**A Detailed Analysis of the Wholist-Analytic Style Ratio: A  
Methodology for Developing a Reliable and Valid Measure  
of Style**

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<b>SECTION III.....</b>	<b>193</b>
CHAPTER 9: TESTING THE VALIDITY OF THE WHOLIST-ANALYTIC RATIO.....	195
CHAPTER 10: TESTING THE EFFECT OF DIMINISHED REFLECTION ON THE RELIABILITY OF THE WHOLIST-ANALYTIC RATIO.....	231
CHAPTER 11: TESTING THE UNIDIMENSIONAL THEORY OF WHOLIST-ANALYTIC STYLE – PART I.....	255
CHAPTER 12: TESTING THE UNIDIMENSIONAL THEORY OF WHOLIST-ANALYTIC STYLE – PART II.....	273
<b>SECTION IV.....</b>	<b>286</b>
CHAPTER 13: DISCUSSION.....	288
<b>REFERENCES .....</b>	<b>331</b>
<b>LIST OF APPENDICES.....</b>	<b>344</b>
APPENDIX 1: IMPERSONAL, ANALYTIC STYLE VERSUS INTERPERSONAL, GLOBAL STYLE.....	346

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## **Abstract**

Riding's (1991) wholist-analytic dimension of cognitive style proposes a unidimensional view of global-analytic constructs, however, very little empirical evidence exists in support of a relationship between the styles in the wholist-analytic family, which has led to suggestions that style is best conceptualised as a more complex multidimensional construct (Hodgkinson and Sadler-Smith, 2003).

Another major problem for Riding's (1991) wholist-analytic style construct is its lack of temporal reliability (Peterson, Deary and Austin, 2003; Rezaei and Katz, 2004; Parkinson, Mullally and Redmond, 2004; Cook, 2008). Furthermore, the current thesis argues that in addition to problems of reliability, the wholist-analytic dimension lacks predictive and construct validity. This thesis outlines two major methodological limitations with the current wholist-analytic ratio measurement, which have raised doubts over the efficacy of the ratio in discriminating between part processing and whole processing style.

Firstly, the wholist-analytic ratio is confounded by reflective-impulsive style differences (Kagan, Rosman, Day, Albert and Phillips, 1964). Secondly, the nature of the tasks, combined with strategy preferences, set up an asymmetry in the basis of the wholist-analytic ratio.

A new measure of wholist-analytic style, hereafter called the 'Wholist-Analytic Style (WAS) Analysis' has been developed to experimentally manipulate the presentation order of the subtests and the number of parts in the geometric stimuli. Performances on the WAS analysis and the CSA were compared to other styles in the wholist-analytic family to test the unidimensional approach to style.

It was found that the wholist-analytic ratio is confounded by sensitivity to reflective style, with much of its discriminatory power being limited to the first subtest, and

there is an asymmetry in the part-whole processing basis of the wholist-analytic ratio. Furthermore, there is a consistent relationship between reflective-impulsive style and part-whole processing.

This thesis proposes the theory of diminished reflection, which renders the wholist-analytic ratio invalid in its current form. The theory can account for the heretofore-unexplained lack of temporal reliability of the wholist-analytic ratio and offers a practical solution to improve both the validity and stability of the ratio. This thesis offers partial support for the unidimensional perspective of style but makes strong links between reflective-impulsive style and part-whole processing preferences.

**Section I.**

**Introduction and  
Literature Review**

**Chapter 1:**  
**Introduction**

## **Chapter 1: Introduction**

Riding's (1991) conception of wholist-analytic style represents a unidimensional perspective of global-analytic style constructs. This unitary perspective is widely held amongst cognitive style researchers (e.g. Miller, 1987; Riding and Cheema, 1991; Allinson and Hayes, 1996; Ehrman and Leaver, 2003) and holds that many of the bi-polar constructs in the styles literature are measuring different aspects of a single super-ordinate dimension. The logical extension of this theoretical viewpoint is that relationships should be evident between the global-analytic constructs that have been subsumed within the wholist-analytic style family. To date there is very limited evidence to suggest that such relationships exist and this dearth of correlational data has led to suggestions that style is best conceptualised as a more complex multidimensional construct (Hodgkinson and Sadler-Smith, 2003). The lack of consistent evidence in support of the unidimensional perspective may to some extent be attributed to pervasive methodological problems with the methods employed to measure many of the style constructs.

### **1.1 Problems of measurement**

Many of the global-analytic styles lack psychometrically sound methods of measuring them; some of the methods used to measure field independent-dependent style (Witkin, 1950) have been criticised for correlating with fluid ability (Cronbach, 1970; Cronbach and Snow, 1981; Grigorenko and Sternberg, 1997; Sternberg and Grigorenko, 1997); the method used to measure reflective-impulsive style (Kagan et al., 1964) lacks internal validity, temporal reliability and has been argued to be biased toward local processing (Ault, Mitchell and Hartman, 1976; Cairns and Cammock, 1978; Buela-Casal, Carretero-Dios, Santos-Roig and Burmudez, 2003); and the convergent-divergent style dimension (Hudson, 1967) doesn't have a standard measure to assess the construct.

### **1.1.1 Field independent-dependent style measures**

It is widely reported that the Embedded Figures Test (EFT), designed to measure field-independent-dependent style (Witkin, 1950) is a measure of fluid ability rather than a value free bipolar measure of style (Cronbach, 1970; Cronbach and Snow, 1981; Grigorenko and Sternberg, 1997; Sternberg and Grigorenko, 1997). Hayes and Allinson stated, “While Witkin’s theory of field independence-dependence is a theory of cognitive style, the Embedded-Figures Test is a measure of ability.” (Hayes and Allinson, 1994, p. 56). Later revisions of the EFT, like the Childrens’ Embedded Figures Test (CEFT, Karp and Konstadt, 1971) also have problems with validity, the changes made to the EFT to make it child friendly made such a fundamental difference to the scoring and method of the EFT that it ceased to be a measure of field independent-dependent style and instead measured the latency to first response which is a characteristic of reflective-impulsive style.

### **1.1.2 Reflective-impulsive style measures**

Reflective-impulsive style (Kagan et al., 1964) differentiates a tendency to approach novel tasks that are characterised by uncertainty. Reflective individuals approach such tasks with a degree of caution to ensure accuracy, whereas impulsive individuals have a tendency to respond quickly to the detriment of accuracy. The method developed to measure reflective-impulsive style is the Matching Familiar Figures Test (MFFT); it was designed to provide a level of complexity that induces response uncertainty and presents a fixed set of response alternatives from which to choose.

Administration of the test relies heavily on the experimenter accurately recording response latencies to ensure internal consistency and validity. The MFFT has also been shown to have low internal stability (Ault, et al., 1976) and in response to such findings a revised version of the MFFT has been devised, the MFFT-20 has demonstrated greater internal stability and much improved test-re-test reliability (Cairns and Cammock, 1978; Buela-Casal et al., 2003) but lacks discriminative power when used on adult samples (Carretero, Santos-Dios and Buela-casal, 2008). The original version of the MFFT is generally employed in style comparison studies not the psychometrically improved MFFT-20 (e.g. Riding and Dyer, 1983; Jamieson, 1992; Allinson and Hayes, 1996).

The scoring of the MFFT is based on latency to first response and the number of incorrect responses offered. It is the response uncertainty and the scoring method which characterise the MFFT as a measure of reflection-impulsivity rather than the specific nature of the task stimuli; however, Zelniker and Jeffrey (1979) have provided evidence that the task itself may favour local rather than global processing. Therefore the MFFT may be confounded by measurements of local and global processing preferences because of the nature of the tasks employed.

### **1.1.3 Convergent-divergent thinking style measures**

Convergent-divergent thinking style (Hudson, 1967) reflects the relative tendency to favour convergent thinking to generate one correct answer with the tendency to favour divergent thinking to generate a number of possible solutions. There is no validated, reliable test of convergent-divergent thinking; instead convergent thinking is inferred from any test which requires the identification of one correct solution and divergent thinking is inferred from any test, which requires the generation of multiple ideas or solutions. Riding and Cheema's (1991) review of the styles literature suggest that convergent thinking has "usually been inferred from success on tests

which may be based on figural input (such as the EFT; MFFT)” (Riding and Cheema, 1991, p. 200). This is likely to reduce the validity of measurement since responses are potentially confounded by differences in field independent-dependent style and reflective-impulsive style.

Most recent studies have employed verbal or numerical intelligence type items as the measure of convergent thinking and performance on open ended tests such as the object uses test and attribute tests as a measure of divergent thinking (Al Naeme, 1991; Bahar and Hansell, 1999; Runco, 2007; Nielson, Pickett and Simonton, 2008). The assessment of convergent-divergent style relies on relative performance on closed or open tasks but efforts to standardise the scoring of the tasks to aid comparisons sometimes confound style with ability. For example, Al Naeme (1991) and Bahar and Hansell (1999) placed a finite limit on the number of responses to be generated on open-ended tests and therefore rendered the test a measure of ability not style (Hudson, 1967).

It is unlikely that the concept of unidimensional style will be adequately addressed without a systematic assessment and comparison of the global-analytic constructs with a focus on careful selection and validation of the measures used to assess each style. The two pervasive problems with current style measurements are the confounds with ability and with similar style constructs. Since global-analytic styles are theorised to be related, it is all the more important that adequate methodologies and psychometrically sound instruments are employed which control for the influence of other styles and allow a clear picture of relationships to emerge. The current thesis tests the unidimensional perspective of style, constructing and validating three measures of style with the aim to avoid the confounding variables of related style constructs and ability, which pervade the existing measures.

The problems with measurement also extend to the super-ordinate measures of style; Riding’s (1991) wholist-analytic dimension suffers from low temporal reliability

(Peterson et al., 2003; Rezaei and Katz, 2004; Parkinson et al., 2004; Cook, 2008), but is argued to have demonstrated good validity (Riding, 2003). This thesis contends that the wholist-analytic ratio measure is sensitive to differences in reflective-impulsive style. The reduced validity, which is caused by the confounding influence of a related style construct, can offer an explanation for the low temporal reliability reported in the literature.

## **1.2 Reliability and validity of Riding's (1991) wholist-analytic dimension**

Riding (2005a) has acknowledged that the wholist-analytic dimension lacks temporal reliability; he has argued that reliability is desirable in a test but not essential and that validity is a more important characteristic. Riding (2003) provides an example of a test which is valid but not reliable; the startle test as the name suggests request naivety from the participant to assess their startle response, which can only validly be measured on first presentation of the test. Subsequent presentations of the test will not elicit a genuine startle response and therefore the test is valid at the first sitting but has poor temporal reliability. In this situation there is a theoretical explanation for why a test cannot be relied upon to measure the same construct or behaviour twice.

This is not the case for Riding's (1991) wholist-analytic style dimension; to date, no explanation has been provided as to why the wholist-analytic dimension has low temporal reliability. Wholist-analytic style is conceptualised as a stable, relatively fixed characteristic which influences the organisation and processing of information as a whole or as a collection of parts (Riding, 2005); therefore, stability over time should be expected and in this case deemed a necessary characteristic of any valid, psychometric measure of wholist-analytic style, given an adequate sampling and test-retest period (Kline, 2000).

The current thesis provides a much needed explanation for the low temporal stability of the wholist-analytic style measure but in doing so raises questions over the validity of the current methodology, which is employed to assess part and whole processing differences. The wholist-analytic ratio methodology has two important limitations:

Firstly, it confounds individual differences in reflective-impulsive style with part and whole processing styles, which leads to a reduction in the validity and reliability of the measure. Wholist-analytic style is measured by a ratio expressing the relative response latencies to two subtests, the first subtest consists of matching figures tasks and the second subtest consists of embedded figures tasks. Presentation order of the tasks is not counterbalanced and therein lays the problem; reflective characteristics lead to a tendency to approach early test items with caution (Nietfeld and Bosma, 2003; Davies and Graff, 2006) leading to analytic order ratios being produced because of the effects of reflective-impulsive style and not because of the effects of differences in part-whole processing preferences. This effect is based on naivety and response uncertainty, which will dissipate at subsequent test sessions explaining the low reliability reported in the literature.

The second methodological issue relates to the type of tasks employed within the subtests. The wholist-analytic dimension purports to measure the relative ability of respondents to use their preferred processing style compared to their ability to employ their non-preferred style. The implications of the ratio measurement is that the matching figure tasks and the embedded figure tasks are designed to favour whole processing strategies and part processing strategies, respectively, however, this is not strictly the case. The matching figures task does favour a whole processing approach over a part processing approach, but an embedded figures task doesn't just favour a part processing approach, it excludes a whole processing approach.

When this is combined with the prediction that, where possible, part processors and whole processors will habitually employ their preferred style, then an asymmetry has emerged in the nature of the processing being compared between part and whole processors. Part processors will be judged based on the efficacy of a part processing strategy across congruent and incongruent task demands, and whole processors will be judged on their relative ability to whole and part process tasks in congruent task conditions.

The methodological limitations outlined here suggest that the wholist-analytic ratio is sensitive to differences in reflective-impulsive style and also measures the analytics tendency to choose part processing over whole processing whilst measuring the wholists relative ability to part and whole process. These limitations raise doubts over the validity of the wholist-analytic ratio. The theory of diminished reflection proposed here and the hypothesised asymmetry in the nature of processing being measured will be systematically tested in the current thesis.

### **1.3 Validity studies**

A large body of research has been accumulated which informs the validity of the wholist-analytic dimension, demonstrating that the wholist-analytic dimension has successfully discriminated social and interpersonal preferences and functioning (e.g. Riding, 1991; 1994; Riding and Craig, 1998; Riding and Craig, 1999), learning and instructional preferences (e.g. Riding and Sadler-Smith, 1992; Riding and Douglas, 1993; Riding and Watts, 1997; Riding and Al Sanabani, 1998; Sadler-Smith and Riding, 1999), subject preferences (e.g. Riding and Pearson, 1994; Newton, Tymms and Carrick, 1995; Riding and Agrell, 1997; Riding and Grimley, 1999; Riding, Grimley, Dahraei and Banner, 2003; Roberts, 2006) and differences in brain activity (Riding, Glass, Butler and Pleydell-Pearce, 1997; Glass and Riding, 1999).

The unitary perspective of style dictates that the wholist-analytic dimension should predict two types of behaviour; behaviour which can be attributed to preferences in part and whole processing, and behaviour which can be attributed to preferences which are characteristic of related global-analytic constructs. Much of the validity research predicts the latter but provides very little convincing evidence that the wholist-analytic ratio method is successfully discriminating between tasks or preferences on the basis of differences in part-whole processing.

The unidimensional perspective of style makes it possible for the wholist-analytic ratio to be confounded by reflective-impulsive style, as suggested here, and still predict differences which are characteristic of related style constructs.

#### **1.4 Chapter summary and conclusion**

The criticisms of wholist-analytic style outlined above focus on the methodological problems of the wholist-analytic ratio and the poor psychometric properties of the related style measures. It is argued that the wholist-analytic ratio is confounded by reflective-impulsive style and is measuring non-comparable differences in part-whole processing between wholists and analytics. The main aim of the research is to demonstrate that whilst the wholist-analytic construct has sound theoretical foundations, the current ratio method used to measure wholist-analytic style lacks validity and it is the problems with validity which have led to the widely reported lack of reliability, offering a much needed explanation for the problems with temporal reliability. The effects of the methodological limitations, outlined here, on the reliability of the wholist-analytic dimension will be examined and a number of recommendations will be made to improve both the validity and the reliability. Finally, the unidimensional theory of style will be explored by comparing four measures of global-analytic style.

**Chapter 2:**  
**Predictive validity**  
**of the**  
**Wholist-Analytic Dimension**

## **Chapter 2: Predictive validity of the Wholist-Analytic Dimension**

### **2.1 Chapter Introduction**

The wholist-analytic dimension of Riding's CSA (Riding, 1991) is based on the concept that we all have the capacity for part processing and for whole processing but that many of us have an habitual tendency to favour one form of processing over the other. Part processing is the organisation or analysis of an object or situation into separate parts; it is essentially a process of differentiation. Whole processing is the organisation or viewing of an object or situation as a gestalt; it is essentially a process of synthesis.

The wholist-analytic dimension is a bipolar construct with an individual's position along the continuum determined by their relative tendency to organise information in wholes or parts. Those who have a relative tendency for whole processing are termed 'wholists' and those who have a relative tendency for part processing are termed 'analytics'. Some individuals do not demonstrate a processing preference and these are termed 'intermediates'.

Riding and Cheema (1991) proposed the wholist-analytic construct in an effort to consolidate the confusing styles literature; their review identified over thirty different style constructs, which they judged to be measuring different aspects of a single global-analytic style.

#### **2.1.1 The wholist-analytic style family**

The wholist-analytic dimension was theorised to be a super-ordinate style, which encompassed the other global-analytic styles within the wholist-analytic family

(Riding and Cheema, 1991). Five of the most researched styles were termed principal styles, these were: reflective-impulsive style (Kagan et al., 1964); convergent-divergent style (Hudson, 1967); field independent-dependent style (Witkin, 1950); serialist-holist style (Pask, 1972); and, leveller-sharpener style (Holzman and Klein, 1954).

This unitary perspective of global-analytic style suggests that wholists will have a relatively more impulsive, divergent, field dependent, holist, and leveller style. Analytics, on the other hand, will have a relatively more reflective, convergent, field independent, serialist and sharpener style.

### ***Reflective-impulsive style***

Reflective-impulsive style distinguishes between tendencies for careful reflection versus impulsive action. In uncertain situations reflectives are characterised by a tendency to focus on accuracy rather than speed and impulsives are characterised by a focus on speed over accuracy (Kagan et al., 1964).

### ***Convergent-divergent style***

Convergent-divergent style distinguishes those who perform relatively better during tasks which require convergent thinking to achieve one correct answer or open ended tasks which require divergent thinking to generate a number of possible solutions (Hudson, 1967).

### ***Field independent-dependent style***

Field independent-dependent style distinguishes those who are more influenced by surrounding context and whose judgements are more dependent on contextual cues

and those who tend to view objects as independent of their context and are less influenced by contextual cues (Witkin, 1950).

### ***Serialist-holist and leveller-sharpener styles***

Serialist-holist style refers to a tendency to process information in serial or parallel fashion (Pask, 1972). Leveller-sharpener style refers to the tendency to focus on similarities or differences, levellers will blur the distinctions between concepts or groupings and sharpeners will heighten the differences (Holzman and Klein, 1954).

### **2.1.2 Predictive validity**

If a measurement can demonstrate predictive validity then it provides support for the efficacy of the test; predictive validity, as the name suggests, relates to whether a test can predict some other criterion variable (Kline, 2000). In the context of the wholist-analytic dimension, there are two types of criteria which may be predicted: first, criteria that relate to the characteristics and behaviour associated with the super-ordinate dimension of wholist-analytic style; second, criteria that relate to the characteristics associated with the subordinate dimensions of style such as the five principal styles dimensions already described. The two types of criteria will be termed 'super-ordinate predictive validity' and 'subordinate predictive validity' for ease of reference.

Super-ordinate predictive validity should discriminate between performance on tasks, which favour part or whole processing and should discriminate between observed behaviours or preferences, which can be explained in terms of individual differences in part or whole processing.

Subordinate predictive validity should discriminate between performance on tasks which favour impulsive, field dependent, divergent, holist, leveller style characteristics and those which favour reflective, field independent, convergent, serialist, sharpener style characteristics. It should also discriminate between observed behaviours and preferences, which can be explained in terms of individual differences in the characteristics, which define the styles within the wholist-analytic family.

Super-ordinate predictions represent the fundamental individual differences upon which the construct of the wholist-analytic dimension is based. They are the defining characteristics, which distinguish wholists from analytics. A number of super-ordinate predictions have been made and some examples of these have been summarised in Table 2.1.

**Table 2.1: Wholist-Analytic Style: Defining Characteristics (Riding, 1994, p. 5-6, 10 and 15)**

<b>Wholists</b>	<b>Analytics</b>
See a situation as a whole	See a situation as a collection of parts
Difficulty separating a situation into its parts	Good at detecting similarities and differences
Can obtain an overall perspective	Will focus on one or two aspects of a situation to the exclusion of others
Likely to form a balanced view	Likely to form extreme views or attitudes
Will not habitually take a structured approach	Take a structured approach to learning
May need help imposing structure in unstructured situations	Will impose order in unstructured situations
	Will prefer information that is set out in a clearly organised way

This chapter will evaluate a group of studies, which collectively address predictive validity. Many of these studies manipulate the structure of learning material or forms of study in a way that is predicted to differentially affect part and whole processors. Much of the research reviewed takes an inductive approach with post hoc interpretation of results and whilst there is some evidence in support of subordinate predictions, there is very little support for the super-ordinate predictions outlined above.

The substantial body of research which addresses predictive validity of the wholist-analytic dimension has been organised into seven categories: instructional preferences (e.g. Sadler-Smith and Riding, 1999); structural preferences in study material (e.g. Riding and Sadler-Smith, 1992; Riding and Douglas, 1993; Riding and Watts, 1997; Riding and Al Sanabani, 1998;); subject performance (Riding and Pearson, 1994; Newton, Tymms and Carrick, 1995; Riding and Agrell, 1997; Riding and Grimley, 1999; Riding, Grimley, Dahraei and Banner, 2003; Roberts, 2006) ; eye witness memory (Emmet, Clifford and Gwyer, 2003); local-global processing (Peterson and Deary, 2006); EEG asymmetries (Riding et al., 1997; Glass and Riding, 1999) and motor skills (Riding and Al-Salih, 2000).

## **2.2 Wholist-analytic style and instructional preferences**

In this context instructional preferences is an inclusive term used to refer to: preferences in instructional methods (e.g. lectures, tutorials, distance learning, computer assisted learning, role play, discussion groups), preferences for instructional media (e.g. handouts, PowerPoint slides, overhead transparencies, videos, text books, journal articles) and preferences for types of assessment (e.g. examinations, group assignments, multiple choice tests, essays). Sadler-Smith and

Riding (1999) explored the self-reported instructional preferences of wholists and analytics.

Sadler-Smith and Riding (1999) assessed two hundred and forty business students, between the age of eighteen and fifty eight years, on the CSA and a self-report measure of instructional preferences. The instructional preferences inventory was constructed using a five-point Likert scale indicating strong dislike to strong preference for items relating to instructional method, instructional media and assessment preferences. Responses to the instructional preference inventory were subjected to a factor analysis.

Instructional method preferences produced three factors labelled as dependent, autonomous and collaborative instructional preferences. Dependent methods were characterised as lectures, tutorials and surgeries; autonomous methods were characterised as open, distance, flexible learning and computer assisted learning; and, collaborative methods included role-play, discussion groups and business games.

The findings revealed that wholists demonstrated a significantly stronger preference for collaborative methods than analytics. No significant effect of style was reported for autonomous or dependent methods. This finding is consistent with the notion that analytics are more isolated and self reliant (Riding, 1991) and are therefore less likely than wholists to express a preference for role play, discussion groups and business games which involve close interaction with others.

Instructional media preferences produced two factors labelled as non-print based media and print based media. Non-print based media consisted of overhead transparencies, videos, and PowerPoint slides; and, print based media consisted of handouts, workbooks, textbooks, and journal articles.

Wholists expressed a stronger preference than analytics for non-print based media; no effects were reported for print based media. Riding and Sadler-Smith suggested that wholists preferred the non-print based media because it presented an overall view by the visual image and is non-linear in comparison to print based media. However, if the difference between non-print and print-based media is primarily one of visual versus verbal then a main effect of verbal-imagery style should have been evident. It also seems misleading to suggest that videos, overhead projector slides and PowerPoint slides are non-linear.

Assessment preferences also produced two factors, characterised as formal and informal. Formal assessments referred to examinations, tests and essay questions; and, informal assessments referred to individual assignments, group assignments, multiple choice questions and short answer questions.

There were no significant main effects of style on assessment preference and no interaction effects between wholist-analytic style and verbal-imagery style. There was three-way interaction with wholist-analytic and verbal-imagery styles only when sex was introduced as a third factor. According to Sadler-Smith and Riding, wholists had a slightly stronger preference for informal assessment methods. Sadler-Smith and Riding suggested that this is because wholists like the lack of rigid structure, which characterises informal assessment methods; however, it is misleading to suggest that multiple choice questions and individual assignments are not structured.

All of the findings above represented very small effect sizes:  $d = 0.28$  for the difference in collaborative method preference;  $d = 0.12$  and  $0.26$  for the difference in informal assessment preference, the only moderate effect size was produced by the difference in non-print media preference ( $d = 0.50$ ). The small effect sizes may well be a result of a lack of variation in self-reported preferences; participant means were typically between 3 and 4, which is not uncommon when employing five-point Likert scales.

Despite the conclusions drawn by Sadler-Smith and Riding, it is also possible that all the findings can be attributed to social preferences rather than structural differences relating to part-whole processing. The non-print based media is delivered by lecturers and involves social interaction, which is absent from the print-based media. The inclusion of the group assignments in the informal assessment category may have swayed wholist and analytic preferences; Riding and Read (1996) found that students generally preferred group or pair work but wholists had the greater preference for group and pair work and analytics had the greatest tolerance for individual work.

This study, therefore, provides some evidence that wholists and analytics differ in their interpersonal preferences for group or individual instructional methods but provides no evidence for the influence of part-whole processing differences on instructional preferences.

### **2.3 Wholist-analytic style and structural preferences in study material**

The next study more directly addresses differences in structural preferences, which should be predicted by part-whole processing preferences. Riding and Watts (1997) administered the CSA to ninety, fifteen and sixteen year old, female students. They were offered three study skills handouts with an unstructured-verbal format, a structured-verbal format or a structured-pictorial format. The unstructured format was not chosen by anyone, forty-one students chose the verbal format and forty-nine chose the pictorial. A log linear analysis revealed significant interaction between format and verbal-imager style with verbalisers preferring the structured-verbal format and imagers choosing the structured-pictorial format. There was no significant interaction of structure and wholist-analytic style. There was a small interaction effect, which approached statistical significance indicating a wholist

preference for the pictorial format and an analytic preference for the verbal. Riding and Watt's post hoc interpretation of the findings argued that the wholists preferred the pictorial version because it was livelier and the analytics preferred the verbal version because it was more neat and tidy. Neither of these explanations pertains to the defining characteristics of part and whole processing styles.

When given a choice all participants opted for the structured material over the unstructured material; an alternative methodology would be to examine the performance of wholist and analytic individuals when choice is constrained and this approach was taken by Riding and Sadler-Smith (1992)

Riding and Sadler-smith (1992) randomly allocated one hundred and twenty nine, fourteen to nineteen year olds, to one of three types of study material and measured their recall performance. The material, which related to hot water systems, was manipulated by structure, large step or small step; by advance organiser, present or absent; by verbal emphasis, high or moderate; and by diagram type, abstract or pictorial. Three versions were developed 1) Large step, without organiser, high verbal, abstract diagram; 2) small step, without organiser, moderate verbal, pictorial diagram; 3) small step, with organiser, moderate verbal, pictorial diagram.

The high-low verbal emphasis and the abstract-pictorial diagram was expected to differentially affect the performance of verbalisers and imagers; the large-small step structure and the presence or absence of the advance organiser was predicted to differentially affect the wholists and analytics.

Riding and Sadler-Smith did not hypothesise the direction of the effect on wholists and analytics but they did state that Wholists "need help seeing the structure and sections of learning material" and analytics "require a unifying overview to be provided so that they can integrate the sections into a whole view" (Riding and Sadler-Smith, 1992, p. 327). The implication is that the small step structure would

improve the performance of wholists and the presence of an advance organiser would improve the performance of the analytics.

Riding and Sadler-Smith's findings showed that that neither the presence of the organiser or the step size had a differential effect on the recall of wholists and analytics. Similarly, neither the level of verbal material or the abstract 'v' pictorial nature of the diagram had any differential effect on the recall of verbalisers or imagers. They did however find a three-way interaction between wholist-analytic style, verbal-imager style and material format.

They interpreted the findings by introducing the notion of unitary and complimentary styles. They argued that whilst wholist-analytic styles and verbal-imager styles are independent, imager style provides an overall or 'whole' perspective and verbaliser style creates a preference for semantic verbal representations, which are analytic in nature. Wholist-imagers and analytic-verbalisers are described as having unitary styles, which provide either a wholist view or an analytic view, respectively. Analytic-imagers and wholist-verbalisers have complimentary styles, which in combination provide both a whole and part processing facility.

In the light of their findings, Riding and Sadler-Smith suggested that the small step structure provided the greatest benefit for the complimentary styles and that the small step organiser was redundant because wholist-verbalisers and analytic-imagers could "generate a whole view and a more specific analytic view of information" (Riding and Sadler-Smith, 1992, p. 336). No post hoc statistical tests were reported to investigate the nature of the interaction, however, sufficient information was reported to allow a calculation of the effect sizes. There was a large effect from version one (large step) to version two (small step) for the wholist-verbalisers and the analytic-imagers ( $d = -0.83$  and  $-1.86$ , respectively, see Table 2.2) and there was little effect from version two (no organiser) to version three (organiser) ( $d = 0.00$  to  $0.36$ ).

**Table 2.2: Three-way interaction: VI style, WA Style and material format**

	<b>Version 1: Large step No organiser High verbal Abstract diagram</b>	<b>Version 2: Small step No organiser Moderate verbal Pictorial diagram</b>	<b>Version 3: Small step Organiser Moderate verbal Pictorial diagram</b>
<b>Wholist- Verbaliser</b>	66.07, 71.25	91.42, 86.00	89.28, 81.66
	d = -1.86, -0.83		d = 0.15, 0.36
<b>Wholist- Imager</b>	82.14, 70.00	80.21, 75.38	91.07, 81.25
	d = 0.10, -0.50		d = -0.60, -0.44
<b>Wholist</b>	75.71, 70.50	85.09, 80.00	90.00, 81.50
	d = -0.53, -0.63		d = -0.28, -0.11
<b>Analytic- Verbaliser</b>	72.44, 62.85	87.14, 72.00	89.29, 81.66
	d = -0.64, -0.50		d = -0.13, -0.57
<b>Analytic- Imager</b>	53.57, 51.25	87.01, 79.09	87.01, 78.18
	d = -1.78, -1.48		d = 0.00, 0.05
<b>Analytic</b>	65.58, 58.63	87.07, 75.71	88.19, 80.00
	d = -1.00, -0.93		d = -0.07, -0.24

*Note: recall performance means are reported for process-test first, then post- test. Effect sizes (d) show the effect of the difference between version one and version two and the effect of the difference between version two and version three for post and process tests.*

They also argued, “analytic-verbalisers will benefit from an emphasis on discrete elements” (Riding and Sadler-Smith, 1992, p. 336) and stated that the organiser only facilitated the analytic-verbalisers; this is an overstatement of the findings. The difference between the process-test recall in the second and third versions represents a very small effect (d = 0.13); the effect size for the post-test recall is more moderate

( $d = 0.57$ ). It also does not account for the fact that the wholist-imagers also appear to have been facilitated by the organiser ( $d = -0.60$  and  $-0.44$ ).

It is clear from Table 2.2 that all groups performed least well on version one, whether this is due to the large step structure or the high verbal content and abstract diagrams is unclear because the methodology is limited in this regard. It is also clear that the analytics have poorer recall on version one than the wholists; this performance is higher for analytic-verbalisers but lower for analytic-imagers, which reflects the verbal nature of the material. What is not clear is why the wholist-imagers have much better recall on version one than the wholist-verbalisers given the verbal nature of the material.

The manipulation of three variables in this way would have provided more useful results if the methodology had included all combinations of the variables (see Table 2.3) using a mixed design.

**Table 2.3: Suggested variable combinations**

Condition	Step	Organiser	Verbal/Diagram
Version 1	Large	Present	High/Abstract
Version 2	Large	Present	Low/Pictorial
Version 3	Large	Absent	High/Abstract
Version 4	Large	Absent	Low/Pictorial
Version 5	Small	Present	High/Abstract
Version 6	Small	Present	Low/Pictorial
Version 7	Small	Absent	High/Abstract
Version 8	Small	Absent	Low/Pictorial

This issue, combined with a small sample size, approximately ten people per group per condition, does limit the conclusions that can be drawn from the study and have raised the possibility of type two errors.

The lack of a priori hypotheses and the post hoc explanations of findings have done little to validate the central characteristics of wholist and analytic style. There was no significant interaction effect of structure and wholist-analytic style and the three-way interaction with verbal-imager style was not substantiated with post hoc statistical data.

A more effective methodology was employed by Riding and Al-Sanabani (1998). They tested the recall of two hundred pupils aged ten to fifteen years; participants read three passages and after each passage were required to answer twenty questions without referring back to the text. The passages were manipulated between groups by format and conceptual structure. For half of the pupils, each passage was presented as one long paragraph. For the other half each passage contained additional format or conceptual structure; passage one was separated into sections with a title before each section, passage two provided an overview after the text and passage three provided an overview at the beginning of the text.

No significant interaction was found between the use of sections with headings and wholist-analytic style, which is contrary to Douglas and Riding's (1993) results which stated that wholists benefited from a cue to the whole when a title was presented before or after a passage but analytics did not.

There was also no interaction between wholist-analytic style, verbal-imager style and the use of sections with headings which is contrary to the results found by Riding and Sadler-Smith (1992) which found that complimentary styles benefited from a small step structure but unitary styles did not.

Riding and Al-Sanabani (1998) did find some interaction between sections with headings, wholist-analytic style and gender. With paragraph headings, analytics did best for males and females, which directly contradicts Riding and Douglas (1993) who found that wholists benefited from headings but analytics did not. Conversely, without paragraph headings analytics did best amongst the females and wholists did best amongst the males. This three-way interaction with gender cannot easily be explained from a part-whole processing point of view.

With regard to the effects of conceptual structure, there was no interaction between the presence and absence of an overview with wholist-analytic style, regardless of whether the overview was at the beginning or end of the passage; there was also no interaction between overview, wholist-analytic style and verbal-imager style. This is not consistent with Riding and Sadler-Smith's (1992) results, which lead to the expectation that unitary styles would be facilitated by an overview.

The only statistical interaction involving wholist-analytic style is that with gender and overview. The pattern was similar to the previous findings with paragraph headings; when the overview was present analytics did better than wholists amongst the males, but there was no difference between analytics and wholists amongst females; and without the overview wholists performed best amongst males and analytics performed best amongst females.

In summary, the studies that have directly manipulated the structure of study materials have provided no support for the predictive validity of the wholist-analytic dimension with regards to either super-ordinate or subordinate predictions. There is no evidence to suggest that the manipulation of structure or format has a differential effect on wholists and analytics. Some three-way interaction with structure, verbal-imagery style and wholist-analytic style was found (Riding and Sadler-Smith, 1992) which led to post hoc interpretations that invoked the notion of complimentary and

unitary styles. However, these findings were not substantiated with post hoc statistical tests and were not replicated by Riding and Al-Sanabani (1998).

There were some significant three-way interactions between verbal-imager styles, wholist-analytic styles and gender (Riding and Al-Sanabani, 1998), that is not accounted for by either super-ordinate or subordinate predictions and to some extent contradicted the findings of Riding and Douglas (1993).

## **2.4 Wholist-analytic style and subject performance**

The next group of studies explored the role of cognitive style in science performance. Newton et al., (1995) found that Wholist-Imagers demonstrated lowest performance on GCSE science examinations, with analytic-verbalisers in 3<sup>rd</sup> place, analytic-imagers in 2<sup>nd</sup> place and wholist-verbalisers performing best. Riding and Agrell (1997) tested fourteen, sixteen year old Canadians and found that analytic-imagers performed worst in science, analytic-verbalisers came 3<sup>rd</sup>, wholist-verbalisers came 2<sup>nd</sup> and wholist-imagers performed the best. Riding and Grimley (1999) found superior performance by wholist-imagers, with analytic-verbalisers in 2<sup>nd</sup> place, analytic-imagers in 3<sup>rd</sup> and wholist-verbalisers performing worst.

Riding and Grimley (1999) claimed that unitary styles led to superior performance in science but it is clear from Table 2.4 that these findings have not been replicated. For ease of reference the shaded areas denote unitary styles and the un-shaded areas denote complimentary styles.

**Table 2.4: Complimentary and unitary style groupings in order of best (1<sup>st</sup> place) to worst (4<sup>th</sup> place) performance in Science**

Studies	1 <sup>st</sup> place	2 <sup>nd</sup> place	3 <sup>rd</sup> place	4 <sup>th</sup> place
<b>Newton et al. (1995)</b>	Wholist- Verbaliser	Analytic- Imager	Analytic- Verbaliser	Wholist- Imager
<b>Riding and Agrell (1997)</b>	Wholist- Imager	Wholist- Verbaliser	Analytic- Verbaliser	Analytic- Imager
<b>Riding and Grimley (1999)</b>	Wholist- Imager	Analytic- Verbaliser	Analytic- Imager	Wholist- Verbaliser

*Note: Unitary style combinations shaded*

The results are also equivocal when considering the effect of wholist-analytic style; Riding and Grimley (1999) examined performance on multi-media learning in science in comparison to traditional learning methods in science. They found superior performance by analytics in the traditional learning mode and superior performance by wholists in the multi media mode. Riding and Grimley (1999) suggested that the difference exists because analytics have trouble with small viewing windows, which is characteristic of multi media methods, which makes it more difficult to obtain a whole view. However, this contradicts the findings of Riding and Pearson (1994).

Riding and Pearson (1994) assessed the cognitive style of one hundred and nineteen, twelve to thirteen year olds (sixty-three males and fifty-six females) and examined the effect of style on performance in six traditionally taught subjects. Wholists

showed superior performance in geography and French; intermediates showed superior performance in English, history and science. Analytics performed poorly in science, geography and French.

Conversely, Riding et al. (2003) found analytics achieved better attainment ratings in science than wholists. The effect of style on attainment was examined for ten subjects (music, art, technology, English, history, maths, science, languages [German or French], religious education and geography). Science was the only subject that produced a main effect of wholist-analytic style. Attainment was operationalised as teacher ratings based on a five-point scale and is therefore subjective, this is particularly important because ratings were reported by each subject tutor and there may be a bias in the wholist-analytic style of an individual who chooses to teach science which may impact on the ratings of their students.

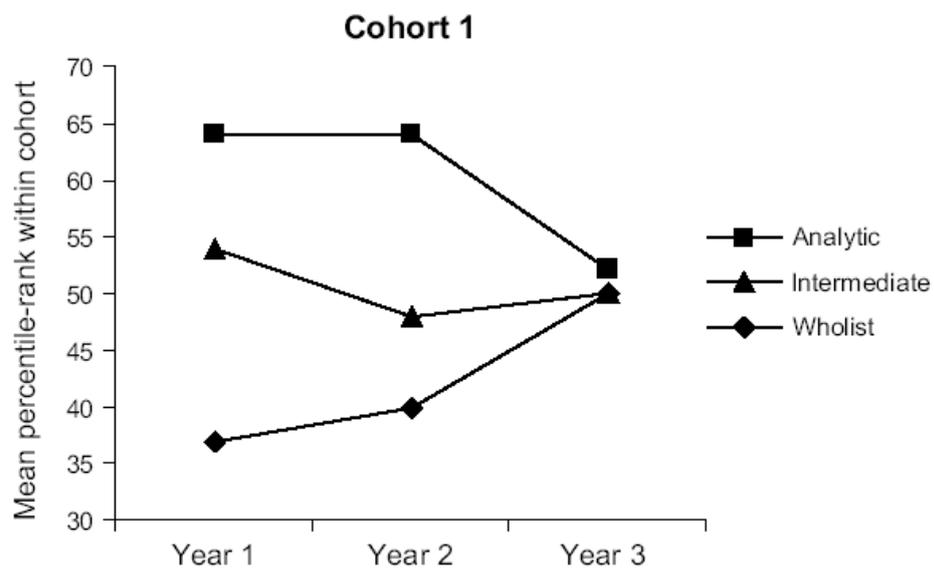
The findings relating to influence of cognitive style on science performance are mixed and perhaps that is to be expected since most of the methodologies are based on unipolar measures, which are likely to confuse ability with style differences. From this perspective Riding and Grimley's (1999) study comparing relative performance on traditional and multi media methods is likely to yield the most informative results.

Roberts (2006) also considered subject performance, this time architecture rather than science. He examined the performance of wholists and analytics at each stage of an undergraduate architectural course, hypothesising that wholists would perform better than analytics. The longitudinal component of the study allowed performance to be compared at year one, two and three. Roberts described the degree course as very structured in year one; students were introduced to architectural vocabulary and required to complete workbooks and exercises to prepare and assist them with their project design work. As the course progressed through year two and three the structure diminished and greater freedom and exploration was allowed and indeed

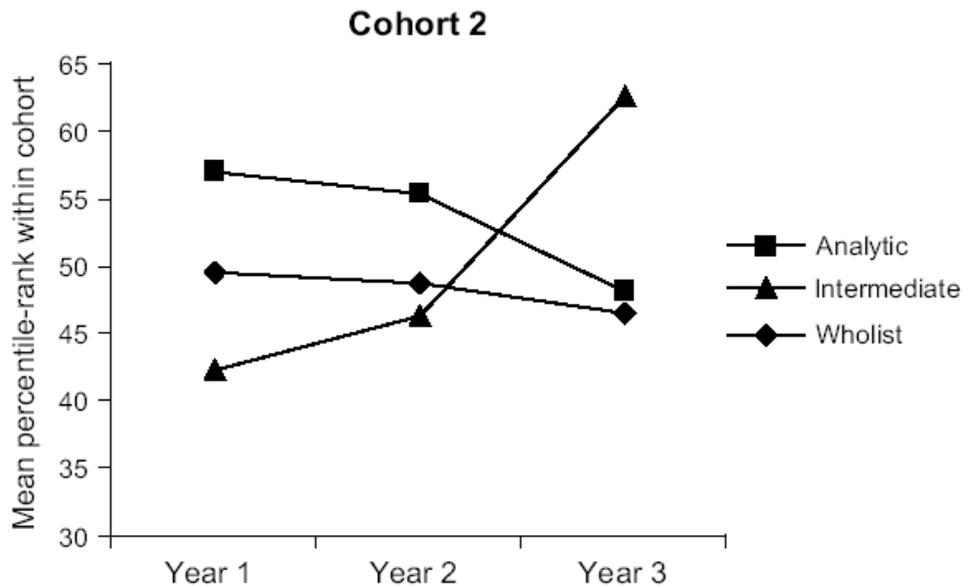
34

required. Roberts anticipated that, since architectural design is an inherently uncertain process, wholists would perform better with the uncertainty and lack of structure whereas analytics would inappropriately impose structure on the subject matter to the detriment of their project design success.

The results did not support the hypothesis that wholists would perform better than analytics; in fact, analytics performed significantly better than wholists in year one but by year three there was no significant difference in rank performance. Roberts replicated these results with a second cohort of students see figures 2.1 and 2.2.



**Figure 2.1: Longitudinal Percentile rank performance of by cognitive style: Cohort 1 (Reproduced with permission, Roberts, 2006)**



**Figure 2.2: Longitudinal Percentile rank performance of by cognitive style: Cohort 2 (Reproduced with permission, Roberts, 2006)**

In cohort one a significantly greater number of wholists dropped out of the course than analytics but this findings was not replicated in cohort two.

This study does provide some support for the notion that analytics perform better than wholists during more structured learning tasks. Whether these differences can be attributed to the structure of the learning material per se or to the need for convergent thinking is unclear. The tasks in year one required assimilation of information to produce correct answers whereas in the latter years students are encouraged to apply divergent thinking to produce one of many possible solutions as the framework and structure of assessment diminishes.

The above studies, that have addressed the effects of wholist-analytic style on subject performance, have found some significant differences in science performance. However these differences have been contradictory; Riding and Grimley (1999)

found that unitary styles demonstrated superior performance in science compared to complimentary styles but this finding contradicts those of Newton et. al. (1995) and Riding and Agrell (1997).

Similarly, using traditional learning methods some researchers have demonstrated that analytics have superior performance in science (Riding and Grimley, 1999; Grimley et al. 2003); others have demonstrated superior performance in intermediates (Riding and Pearson, 1994); and still more have demonstrated superior performance in wholists (Riding and Agrell, 1997).

Using a related design, Riding and Grimley's (1999) study provides some evidence that wholists perform better in science subjects using a multi media method and analytics perform better in science subjects using traditional instruction methods. They interpreted this difference in terms of the analytics having difficulty with the small viewing window afforded by the multi media methods. This finding does relate to super-ordinate predictions but unfortunately has not been replicated.

Roberts (2006) also found differences in the performance of wholists and analytics in the first year of an architectural course; the findings were replicated in a second cohort. The results can be interpreted in terms of convergent and divergent style differences and therefore relate to subordinate predictions of validity.

## **2.5 Wholist-analytic style and eye witness memory**

The next study effectively posed a super-ordinate and subordinate prediction. Emmet, Clifford and Gwyer (2003) examined the relationship between field independent-dependent and wholist-analytic styles and the efficacy of context reinstatement in improving eyewitness recall of staged events. Since wholist-analytic style and field independent-dependent style are related constructs they

should be similarly effected by the presence or absence of context reinstatement in eyewitness recall, therefore posing a subordinate prediction. Further, Field independence-dependence is essentially measuring one end of the wholist-analytic dimension, that is, the ability to part process by disembedding a figure from its ground, therefore posing a super-ordinate prediction.

Field independent-dependent style was assessed using the group embedded figures test (GEFT, Oltman, Raskin and Witman, 1971) and wholist-analytic style was assessed by the CSA. In a sample of forty-four undergraduates, context reinstatement significantly improved free recall of eyewitness events but the beneficial effects of context reinstatement were significantly greater for field dependents than field independents. These results were replicated in a second experiment using a different sample of seventy-nine students. For cued recall, context reinstatement had no effect and field independents out performed field dependents. In the second experiment, field independents did perform better than field dependents for cued recall but the results did not reach significance.

In view of these results and the conceptual similarity of the field independence-dependence style and the wholist-analytic dimension, wholists were expected to show a relatively greater improvement in free recall than analysts when context is reinstated. Analytics were also expected to out perform wholists in cued recall situations. However, the results revealed that there was no significant interaction between wholist-analytic style and context reinstatement on free recall and no significant effect of wholist-analytic style on cued recall performance.

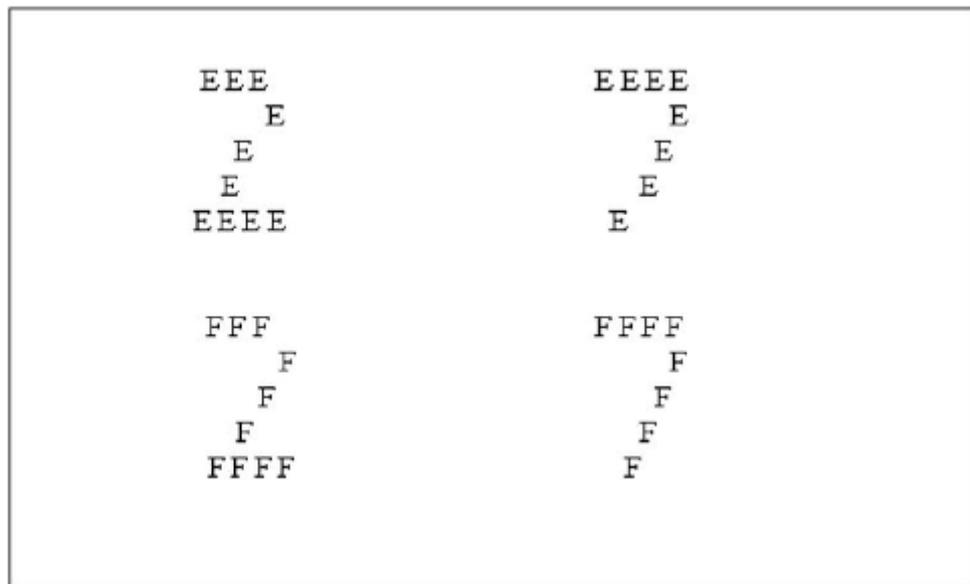
The failure of wholist-analytic style to interact with context reinstatement in the same manner as field independent-dependent style led Emmett et al. (2003) to suggest that “the CSA and the GEFT do not have a set-inclusion relation and that whatever lies as a difference between the two tests may contain the essential element

in mediating context reinstatement susceptibility and memorial performance.” (Emmett et al., 2003, p.1506).

## **2.6 Wholist-analytic style and local-global processing**

The study, which appears to have most directly tested a super-ordinate prediction by assessing the ability of wholists and analytics to employ part and whole processing, is Peterson and Deary (2006). They explore the performance of wholists and analytics on the Wholist-Analytic Inspection Time task (WAIT). The WAIT employs Navon-type stimuli (Navon, 1977), which present a number constructed by letters, or a letter constructed by numbers, see Figure 2.3. Participants were instructed to ‘look global’ or ‘look local’ prior to each trial and each participants WAIT style score is a ratio of their accuracy on global items to local items over 320 time limited trials.

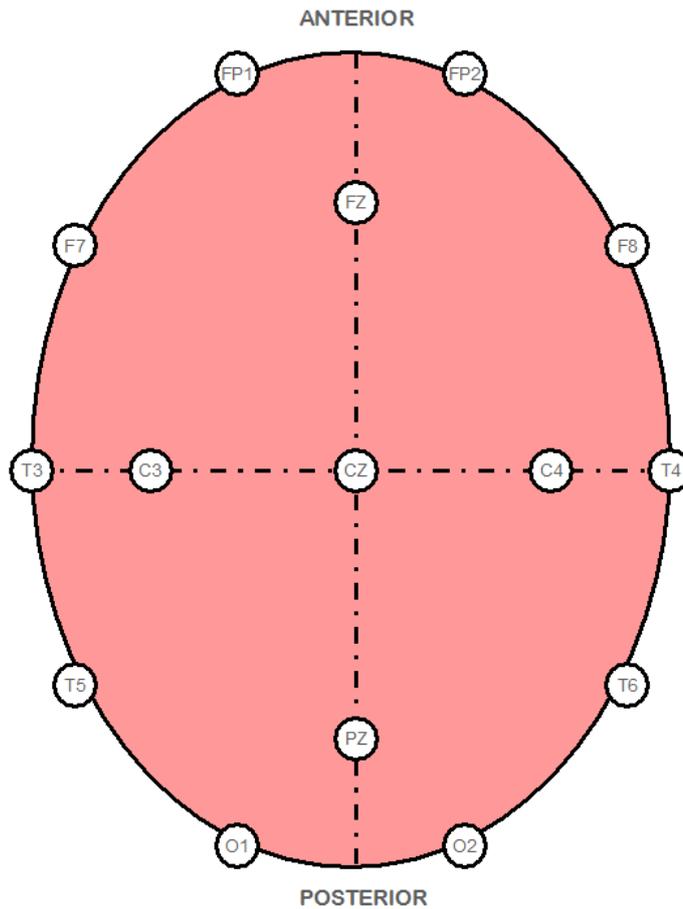
Peterson and Deary found no significant relationship between the wholist-analytic style measures on the E-CSA and the WAIT ( $r = .158$ ). It should be noted, however, that the WAIT is a newly constructed test and in this study Peterson, Deary and Austin’s (2003) extended version of the CSA was used rather than Riding’s unmodified version.



**Figure 2.3: Example of Wholist-Analytic Inspection Time (WAIT) task stimuli (Reproduced with permission, Peterson and Deary, 2006)**

### **2.7 Wholist-analytic style and EEG asymmetries**

Some limited electroencephalogram evidence has been provided linking wholist-analytic style differences with asymmetries in alpha wave activity during the completion of cognitive tasks (Riding, Glass, Butler and Pleydell-Pearce, 1997; Glass and Riding, 1999). This small-scale study, consisting of fifteen volunteers, nine males and six females, is the only one that has compared style differences, as measured by Riding's CSA, with EEG recordings. Riding et. al.'s (1997) paper reported the findings of the alpha rhythm recordings and Glass and Riding's (1999) paper reported the theta, delta and beta rhythm recordings for the same participants.



**Figure 2.4: Electrode positions (Riding et. al., 1997; Glass and Riding, 1999)**

Fifteen electrodes were used in the positions shown in Figure 2.4. Five over the frontal lobe, two in frontal polar positions (F7, FZ, F8, FP1, FP2); three positioned centrally posterior to the frontal lobe (C3, CZ, C4); four in the temporal lobe area (T3, T4, T5, T6); one in the Midline, parietal region (PZ); and two in the occipital lobe (O1, O2).

Participants were presented with words and required to press a button whenever the words represented a fruit or a vegetable whilst their EEG output was recorded. This is a semantic task, which is reminiscent of the verbal trials in the CSA. There were five task conditions of increasing difficulty ranging from words displayed one at a

time for half a second to pairs of words being presented for a tenth of a second. No task performance measures were recorded.

This exploratory study had no clear predictions relating to the location of the alpha asymmetries other than they expected wholists and analytics to have significantly different levels of alpha in some locations and that the differences were unlikely to be straightforward hemispheric asymmetries.

They found that wholists had higher mean alpha output at all locations; these were significantly higher at all electrode sites except FP1, FP2 and T4. Means and standard deviations for alpha output are provided in Table 2.5.

Baseline alpha readings with eyes open or closed were not taken so the alpha levels cannot show phasic change. However, it would be unlikely that analytics have significantly lower baseline alpha levels at rest. Therefore, the implication is that greater alpha suppression occurred at all locations during the tasks for analytics.

The greatest alpha suppression for both wholists and analytics was at T4, in fact the top seven areas, which indicate the greatest suppression, for both wholists and analytics mainly occurred in the lateral sites in the frontal and temporal lobes and the least suppression in the paramedial sites in the parietal lobes, occipital lobes and in the midline sites. This makes sense since working memory and the production area for speech are processed in the frontal lobe and the understanding of verbal information and the naming and categorising of visual stimuli is processed in the temporal lobe.

**Table 2.5: Alpha level means and standard deviations at all locations by wholist-analytic style**

Electrode position	Mean Alpha Output		Standard deviation	
	Wholist	Analytic	Wholist	Analytic
<b>FP1</b>	1893	1324	791	557
<b>FP2</b>	1818	1291	634	584
<b>F7*</b>	1319	650	752	183
<b>F8*</b>	1189	614	596	251
<b>FZ*</b>	2276	1115	1082	423
<b>C3*</b>	2031	525	1206	253
<b>C4*</b>	2014	933	903	345
<b>CZ*</b>	2856	1296	1342	542
<b>T3*</b>	1682	525	1599	253
<b>T4</b>	1002	508	721	271
<b>T5*</b>	1996	637	1322	238
<b>T6*</b>	1904	572	1348	265
<b>PZ*</b>	5272	1045	1045	309
<b>O1*</b>	3854	1236	2464	526
<b>O2*</b>	3763	1088	2331	493

\*  $P < 0.05$

**Table 2.6: Electrode locations from greatest alpha suppression to least suppression for wholists and analytics**

Wholist		Analytic	
Location	Alpha	Location	Alpha
T4 (L)	1002	T4 (L)	508
F8 (L)	1189	T3 (L)	525
F7 (L)	1319	C3 (PM)	525
T3 (L)	1682	T6 (L)	572
FP2 (PM)	1818	F8 (L)	614
FP1 (PM)	1893	T5 (L)	637
T6 (L)	1904	F7 (L)	650
T5 (L)	1996	C4 (PM)	933
C4 (PM)	2014	PZ (M)	1045
C3 (PM)	2031	O2 (PM)	1088
FZ (M)	2276	FZ (M)	1115
CZ (M)	2856	O1 (PM)	1236
O2 (PM)	3763	FP2 (PM)	1291
O1 (PM)	3854	CZ (M)	1296
PZ (M)	5272	FP1 (PM)	1324

*(L) – lateral sites, (M) – midline sites, (PM) – Paramedial sites*

Phasic changes in the form of decreasing alpha levels, or suppression is associated with greater performance (Klimesch, 1999). The lower alpha levels produced by analytics may have been associated with greater accuracy; this interpretation was acknowledged by Riding et. al. (1997). Since task accuracy was not measured this

cannot be explored. What Riding and colleagues failed to consider was that greater alpha suppression might also indicate greater attention (Shaw, 1996). Klimesch (1999) stated that 'lower alpha' de-synchronisation between 6-10 Hz relates to non-task, non-stimulus factors, which can be best considered as attention, stating "It is topographically widespread over the entire scalp and probably reflects general task demands and attentional processes" (Klimesch, 1999, p. 183)

Given the widespread difference in the alpha levels across all locations it seems the analytics were devoting more attentional processes to the task at hand. The findings also revealed a significant, within subjects, effect of task with alpha levels decreasing as the tasks became more difficult which was apparent for wholists but not for analytics. This suggests that wholists devoted more attention as the tasks became more difficult; the trend was apparent for analytics but far less pronounced.

The higher alpha band between 10 and 12 Hz is thought to reflect sensory-semantic processing and de-synchronisation is topographically restricted (Klimesch, 1999). Riding et. al's., (1999) study used an alpha range of 8-13 Hz and made no distinction between upper and lower alpha bands so they are likely to have confused attentional processes with semantic processing. In the light of this, widespread differences across the scalp will be interpreted as attentional differences but topographically restricted differences will be interpreted as task related.

Riding et. al.'s main finding was that there seems to be an anterior-posterior asymmetry between wholists and analytics, stating that "wholists do relatively least processing at posterior regions (over occipital, visual cortex) and analytics most." (Riding et. al., 1997, p. 227) They interpreted this as support for the notion that "analytic processing may be located in the higher level visual systems"(Riding, Glass and Douglas, 1993: Ungerleider and Mishkin, 1982, Riding et. al., 1997, p. 227).

However, this interpretation of the findings implies a double dissociation between style and anterior-posterior processing which is rather misleading, whilst wholists do demonstrate the least processing at posterior areas in comparison to other areas, analytics do not do the most processing in posterior areas compared to other areas; it would be more accurate to suggest that the analytics demonstrated widespread suppression across all areas of the scalp with little difference between anterior and posterior positions whereas the wholists demonstrated less processing in the posterior areas; wholist alphas were significantly higher in Pz than Fz and CZ and significantly higher in O1/O2 than in C3/C4 and FP1/FP2.

Whilst Glass and Riding (1999) offered an explanation for the difference in alpha levels between the analytics and wholists in the occipital regions they failed to offer an explanation for the differing levels of activity in the posterior parietal lobe; stating “the characteristic of analytics that their posterior parietal lobes ...are more active in the solution of verbal-analytic tasks than the parietal lobes of wholists...[was] unexpected”(Glass and Riding, 1999, p. 36).

This cannot easily be explained in terms of part-whole processing differences; however, this can be neatly explained by the role of error monitoring which can be associated with reflective style.

Greater alpha suppression and theta power at Pz is linked with error response processing (Cohen, Elger and Ranganath, 2006). Glass and Riding (1999) considered the widespread cortical activation of the analytics to indicate greater arousal which also is consistent with the notion that reflective style is characterised by a motivation to be accurate and an anxiety which motivates the individual to avoid errors.

The error-checking hypothesis outlined above predicts that theta power would be higher at Pz for analytics than wholists. Theta and alpha power tend to work in

opposite directions so during phasic change theta will increase and alpha will decrease with increasing performance and that theta will decrease and alpha will increase with decreasing performance (Klimesch, 1999).

Glass and Riding (1999) findings suggest that wholists actually had higher theta output at all midline sites including Pz, which is contrary to the error-checking hypothesis suggested here and also contrary to the expectation that alpha and theta have a reciprocal and opposite relationship (Klimesch, 1999).

However, Glass and Riding characterise theta output as 3 to 7.9 Hz which overlaps with the lower alpha range 6 to 10 hz suggested by Klimesch's (1999) review. Therefore the lower theta power in analytics reported here might be a result of inadequate banding and an artefact of the analytics having increased lower alpha suppression, which represents greater arousal and attention.

The EEG evidence outlined above is often given undue weighting with regard to its support for the validity of the wholist-analytic dimension. The study revealed three interesting findings: 1) Analytics demonstrated greater alpha suppression than wholists in all areas; 2) Wholists demonstrated least alpha suppression at the midline parietal region compared to the midline frontal and central regions; 3) Wholists demonstrated least alpha suppression in the paramedial occipital regions than in the paramedial frontal and central regions

These findings suggest that the wholist-analytic dimension does discriminate between those labelled as wholists and those labelled as analytics and therefore provides some validation that the dimension is sensitive to something. This exploratory study made no super-ordinate or subordinate predictions and could not easily interpret the findings in a way that supported the predictive validity of the wholist-analytic dimension.

Glass and Riding (1999) had difficulty interpreting the first two findings in terms of wholist-analytic characteristics and interpreted the third finding as evidence that analytic processing may be located in the higher visual systems. However, the findings may be more easily interpreted by considering differences in reflective-impulsive style characteristics.

The greater arousal and/or attention, which was evident in the analytics from the widespread alpha suppression across the scalp and the greater activation of higher visual areas and areas associated with response error monitoring are indicative of reflective characteristics which focus on task accuracy.

## **2.8 Wholist-analytic style and motor skills**

The literature on motor skills has very little bearing on the predictive validity of the wholist-analytic dimension but it does serve to highlight the pitfalls of generating post hoc interpretations as a result of inductive research with no theoretical underpinnings.

Pargam (1993) reviewed the small body of styles literature on motor skill and sports performance and concluded that there was little evidence of a relationship. However, since then, two studies have been reported which propose a link between motor skill and style.

Riding and Al-Salih (2000) tested participants on the CSA and found that wholists were more accurate at throwing a ball, this effect had not been predicted and their post hoc interpretation amounted to the statement “Presumably accurate throwing requires the ability to analyse” (Riding and Al-Salih, 2000, p. 29).

Opposing findings were reported by, Keller and Ripoll (2001; 2004) who tested participants using the matching familiar figures test (Kagan, Rosman, Day, Albert and Phillips, 1964) and found that reflective individuals were more accurate at hitting a ball with a tennis racquet. Reflective participants were also more accurate at catching a ball (Keller and Ripoll, 2004).

These findings do not pertain to super-ordinate predictions relating to part-whole processing differences and to the limited extent that they pertain to subordinate predictions, which relate to other styles in the wholist-analytic family, they do not support the prediction that tasks that favour wholists would be expected to favour impulsive individuals.

## **2.9 Chapter summary and conclusions**

The research presented here represents commonly cited studies in support of the validity of the wholist-analytic dimension. However, on closer inspection they fail to adequately demonstrate predictive validity.

The central characteristics of wholist-analytic style, defined by Riding (1994) and summarised in Table 2.1, have not been adequately demonstrated. In particular there is no evidence that wholists see a situation as a whole, can obtain an overall perspective, form balanced views and have difficulty separating a situation into its parts; and no evidence that analytics see a situation as a collection of parts, are good at detecting similarities and differences, will focus on one or two aspects to the exclusion of others or are likely to form extreme views or attitudes. In the only study that directly assessed the tendency of wholists and analytics to process globally or locally, there was no relationship between wholist-analytic style and local-global processing (Peterson and Deary, 2006). Wholist-analytic style also failed to interact

with context reinstatement in eyewitness memory in the same way as field dependent-independent style did (Emmet et al., 2003).

There is some support that analytics perform better than wholists in structured learning situations, which is evident from their greater success in a level one architecture course; but the suggestion that analytics may inappropriately impose order in unstructured situations was not supported by their performance in the third year of their architecture course (Roberts, 2006).

There is also very little evidence to suggest that wholists need help imposing structure in unstructured situations or that they benefit from such help since there is no consistent evidence linking wholist-analytic style with learning performance when the structure of learning material has been manipulated. Riding and Sadler-Smith found no significant interaction effect of structure and wholist-analytic style when manipulating either small step versus large step or presence or absence of an advance organiser. Douglas and Riding (1993) did find that the presence of a title benefited wholists rather than analytics but this was not replicated by Riding and Al-Sanabani (1998) who found no significant interaction between the use of sections with headings and wholist-analytic style.

Riding and Sadler-Smith (1992) found evidence to suggest that complimentary styles benefited from a small step structure but unitary styles did not, but again this was not replicated by Riding and Al-Sanabani (1998) who found no interaction between wholist-analytic style, verbal-imager style and the use of sections with headings.

In addition, the effect of style on performance in relatively more structured subjects such as science has been equivocal (Newton et al., 1995; Riding and Agrell, 1997; Riding and Grimley, 1999; Riding and Pearson, 1994; Riding et al., 2003)

In fact the whole notion of structural preferences is ill defined and rather contradictory Riding (1994, p.10) suggested that wholists “will not habitually take a structured approach” and “may need help imposing structure in unstructured situations” which implies that increased structure will benefit wholists. Compare this to Ridings (1994, p. 10) suggestion that analytics “take a structured approach to learning” and “will prefer information that is set out in a clearly organised way” which also implies that increased structure will benefit analytics. When considered from this perspective, it seems illogical to predict differences in performance between wholists and analytics when the structure of material is manipulated.

On a more positive note, there is some evidence that the wholist-analytic dimension discriminates between interpersonal and impersonal styles, which are characteristic of other global-analytic styles constructs and therefore support subordinate predictive validity.

Sadler-Smith and Riding (1999) found two effects of wholist-analytic style on instructional preferences; wholists had a stronger preference than analytics for collaborative methods like role play and also a stronger preference for non-print based media like overhead transparencies and power points.

Sadler-smith and Riding (1999) interpreted the preference for collaborative methods as relating to interpersonal differences, for instance wholists are more gregarious and socially dependent (Riding, 1991). This could also explain the preference for non-print based media given the interpersonal interaction that is associated with the use of overhead transparencies and PowerPoint slides. Sadler-smith and Riding (1999) explained the wholists preference for non-print based media in terms of such materials being image based and non-linear but it seems misleading to suggest that PowerPoint slides and overhead transparencies are non-linear and they frequently consist of verbal material.

Perhaps the most convincing support for the wholist-analytic dimension is the EEG data (Riding et al., 1997; Glass and Riding, 1999) which demonstrated that analytics had more widespread and greater activation across the scalp during a semantic verbal task than the wholists and the wholists registered more activity in the anterior areas, the frontal and central parts of the scalp, than the posterior areas, the parietal and occipital lobes. The EEG data suggests a physiological basis for the differences between wholists and analytics but it does not validate the notion that wholists are whole processors and analytics are part processors.

Further, the EEG data only pertains to predictive validity in so much as a difference in brain activity is expected and to-date this has not been replicated. Understandably, the EEG studies are inductive and the data difficult to interpret, however, the differences in alpha levels can be more easily interpreted in terms of individual differences in reflective-impulsive style characteristics than by explanations employing whole or part processing differences.

Predictive validity of the wholist-analytic dimension has not been adequately established. There is no convincing evidence in support of super-ordinate predictions, which relate to the central characteristics of wholist-analytic style but there is some evidence supporting the validity with which it predicts subordinate characteristics, particularly interpersonal differences. The link between wholist-analytic style and interpersonal differences is an interesting one for two main reasons.

Firstly, it echoes a distinction that has been drawn independently from a number of other styles, most notably; field independent-dependent style (Witkin, 1950) and convergent-divergent style (Hudson, 1967). The evidence for this recurring distinction and the implications of association between interpersonal differences and global-analytic processing styles is discussed in appendix one.

Secondly, and perhaps more importantly in the context of the current discussion of validity, the common distinction between interpersonal and impersonal styles provides a link between field independent-dependent style, convergent-divergent style and wholist-analytic style which supports Riding's unidimensional view of global-analytic style. This unitary perspective is fundamental to the construct validity of the wholist-analytic dimension but despite a strong theoretical basis and widespread agreement (Miller, 1987; Riding and Cheema, 1991; Allinson and Hayes, 1996; Ehrman and Leaver, 2003), to-date there is limited evidence to demonstrate the link between the global-analytic styles. The lack of an evidential link and the doubts, which this raises over the construct validity of the wholist-analytic dimension, is discussed in Chapter three.

**Chapter 3:**  
**Construct Validity**  
**of the**  
**Wholist-Analytic Dimension**

## **Chapter 3: Construct Validity of the Wholist-Analytic Dimension**

### **3.1 Chapter Introduction**

Riding and Cheema's (1991) conception of wholist-analytic style was based on the notion that the global-analytic styles identified in the literature were actually measuring different aspects of a super-ordinate, wholist-analytic dimension. This conception of style represents a unitary or unidimensional perspective of global-analytic style differences; the unitary perspective is widely held (Miller, 1987; Riding and Cheema, 1991, Allinson and Hayes, 1996; Ehrman and Leaver, 2003).

The unitary perspective predicts that similar conceptions of global-analytic styles will be related to each other. At the analytic pole: individuals will be reflective in their approach to situational uncertainty and will focus on ensuring accuracy; they will have a preference towards convergent thinking tasks; they will demonstrate superior disembedding skills associated with field independence; they will take a serialist approach and will distort the boundaries between groups and categories. At the wholist pole: individuals will be impulsive in uncertain situations; they will excel at divergent thinking relative to convergent thinking tasks; they will demonstrate inferior disembedding skills associated with field dependence; they will take a holist approach to processing and will blur the boundaries between groups and categories.

The construct validity of the wholist-analytic dimension is dependent on there being a correlation between the styles in the wholist-analytic family. Riding and Cheema (1991) reviewed and presented the available evidence linking the five principal styles together; they acknowledged that no correlational evidence existed to suggest a relationship between holist-serialist style and leveller-sharpener style but this was owing to a dearth of studies. Riding and Cheema (1991) did, however provide a

body of evidence linking convergent-divergent style and reflective-impulsive style with field independent-dependent style.

This chapter re-examines the studies presented in Riding and Cheema's (1991) review which considered the relationships between the principle style labels; the chapter also compares the factor analytic studies which provide support for the unitary perspective and examines the limited research which has addressed this issue since Riding and Cheema's review.

It will be argued that Riding and Cheema's model of style has a strong theoretical background but there is very little empirical evidence on which to base their wholist-analytic construct and to date relationships between the styles in the wholist-analytic family have not been satisfactorily demonstrated.

In particular, it will be demonstrated that the studies cited by Riding and Cheema (1991), which provided the only convincing empirical evidence of unidimensional style by demonstrating an association between reflective-impulsive style (Kagan, 1965) and field independent-dependent style (Witkin, 1950) may have been a result of a methodological limitation associated with the Childrens' Embedded Figures Test (CEFT, Karp and Konstadt, 1971).

The CEFT is a version of the embedded figures test, which was adapted for use with young children to test their field independent-dependent style; unfortunately the amendments to the CEFT changed the basis of the measurement from measuring the speed to achieving correct solutions, to measuring the accuracy of the first response. This adaptation rendered the test very sensitive to reflective-impulsive style, which may explain the consistent relationship between reflective-impulsive style and field-independent dependent style when the CEFT is used as a measure of field independence.

### 3.2 The unitary perspective

The unitary perspective is a widely held view; three theorists have proposed similar super-ordinate, global-analytic dimensions (Miller, 1987; Riding, 1991; Allinson and Hayes, 1996) and have integrated the sub-ordinate styles in comparable ways (Riding and Cheema, 1991; Miller, 1987; Allinson and Hayes, 1996).

#### 3.2.1 The wholist-analytic dimension (Riding and Cheema, 1991)

Riding and Cheema (1991) reviewed five principal style labels and judged them “likely to be correlates of the same single cognitive style, which may be termed the wholist-analytic dimension” (Riding and Cheema, 1991, p.205). The styles were vertically integrated as follows:

**Table 3.1: Integration of Wholist-analytic Styles (Riding and Cheema, 1991)**

<b>Wholists</b>	<b>Analytics</b>	
Holists	Serialists	Pask (1972)
Levellers	Sharpeners	Holzman and Klein (1954)
Divergers	Convergers	Hudson (1967)
Impulsive	Reflective	Kagan et al, (1964)
Field dependence	Field independence	Witkin (1950)

This approach to integrating the styles is similar to that of Miller’s (1987) wholist-analytic dimension, and Allinson and Hayes’s (1996) wholist-analytic dimension, and demonstrates the widely held view that Holists, Divergers, Impulsives and Field dependents belong at the global pole and that Analytic, Convergent Reflective, Field independents belong at the analytic pole.

### 3.2.2 The analytic-holist dimension (Miller, 1987)

Miller's (1987) model vertically integrated the styles beneath a super ordinate analytic-holistic dimension whilst horizontally connecting them to different aspects of cognitive processing. The major difference between Miller's analytic-holistic dimension and Riding and Cheema's wholist-analytic dimension is the inclusion of verbal-visual style. Riding and Cheema consider verbal-visual style as independent of wholist-analytic style. However, there is considerable agreement between Miller (1987) and Riding and Cheema (1991) with regard to the inclusion of field independent-dependent style, convergent-divergent style and serial-holist style within the super-ordinate constructs, see Table 3.2.

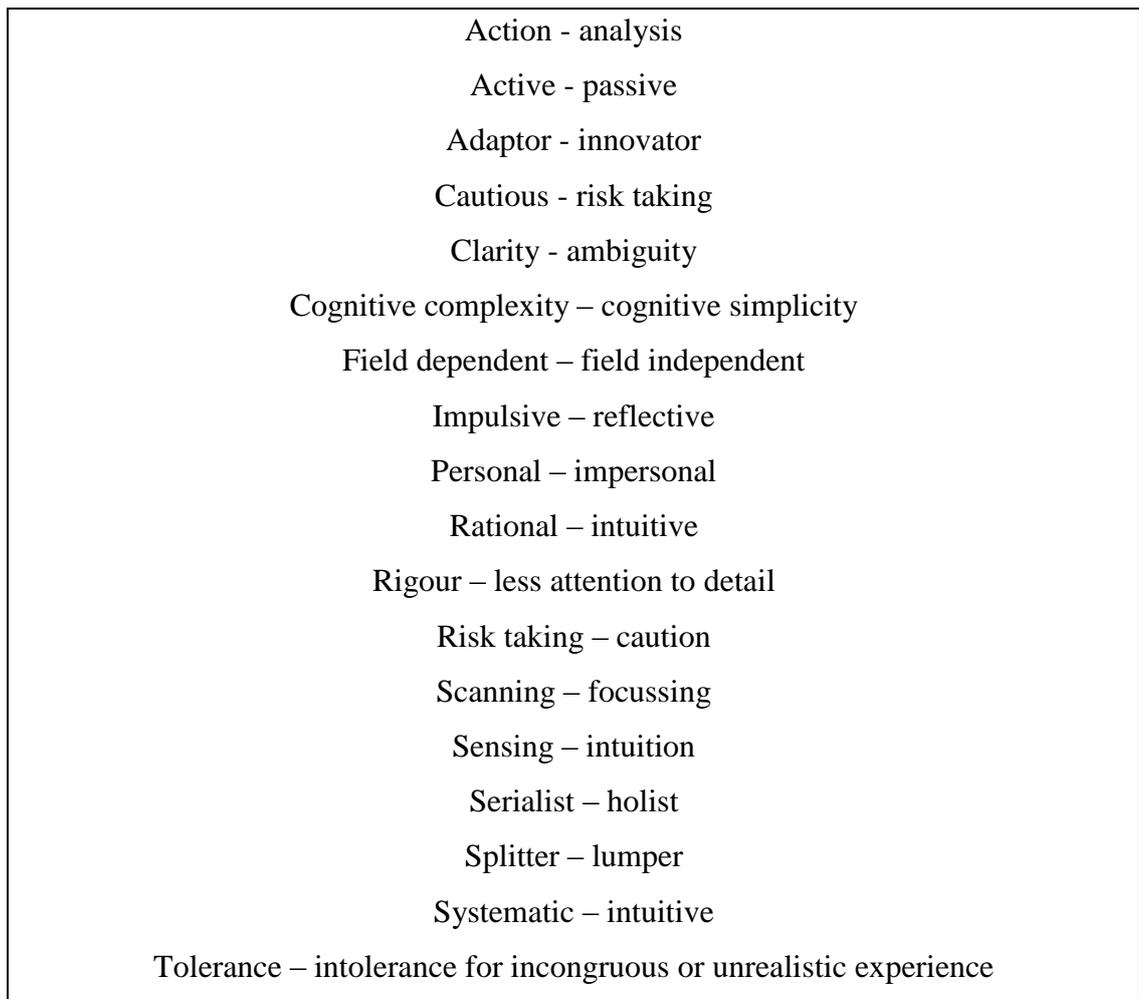
**Table 3.2: Integration of Holistic-Analytic Styles (Miller 1991)**

<b>Analytic Style</b>	<b>Holistic Style</b>
Analytic	Holistic
Field Independence	Field dependence
Verbal/analytic	Visual/analogue
Conceptual differentiation	Conceptual holism
Convergence	Divergence
Serial	Holistic
Tight	Loose
Actuarial	Intuitive

Whilst Miller's (1987) theory of analytic-holist style is similar to Riding and Cheema's (1991) conception, unlike Riding (1991), Miller did not provide a means to measure analytic-holist style.

### 3.2.3 The analytic-intuitive dimension (Allinson and Hayes, 1996)

Allinson and Hayes's (1996) conception of style did not provide a theoretical model of style like those of Miller (1987) and Riding (1991); the analytic-intuitive dimension evolved from a factor analyses in the pursuit of a self report measure of style.



**Figure 3.1: Eighteen style constructs used to create the CSI instrument (Personal communication with C. Allinson, July 2005).**

Hayes and Allinson (1994) reviewed the cognitive styles literature and identified twenty-nine global-analytic styles; they generated four or five statements for each of the twenty-nine styles creating a list of one hundred and twenty nine statements. These were administered to two hundred and ninety one people and their responses were subjected to factor analysis.

Thirty-eight statements loaded sufficiently highly on a single factor, which they labelled analytic-intuitive style; these statements formed the self-report measure, which is known as the Cognitive Styles Index (CSI, Allinson and Hayes, 1996). The statements, which comprise the CSI, were derived from the eighteen styles listed in Figure 3.1 (personal communication with C. Allinson, July 2005).

The trend towards the integration of style constructs and the unitary perspective of style has a strong theoretical foundation but there is very little empirical evidence to support Riding and Cheema's claim that the global-analytic styles are correlates of a single dimension.

### **3.3 Evidence for the unitary perspective**

#### **3.3.1 Holist-serialist and Leveller-Sharpener dimensions**

Riding and Cheema's (1991) review reported, "no empirical evidence exists linking the holist-serialist dimension with other styles of the wholist-analytic family" (Riding and Cheema, 1991. p.204). However, in Allinson and Hayes (1996) factor analysis, holist-serialist statements did load sufficiently highly with reflective-impulsive style statements and field-independent dependent style statements on the analytic-intuitive factor.

Similarly, there were no studies linking leveller-sharpener style to other styles in the wholist-analytic family, however, Riding and Dyer (1983) provided factor analytic evidence that leveller-sharpener style did load highly on the same factor as field independence-dependence.

Riding and Dyer's (1983) factor analysis assessed the performance of one hundred and fifty, twelve year olds on three global-analytic styles: reflective-impulsive style, field-independent-dependent style and leveller-sharpener style; and also assessed them on Betts Imagery Control (Betts, 1909, cited in Riding and Dyer, 1983) and the Junior Eysenck Personality Inventory. Leveller-sharpener style was measured by the schematising test (Holzman and Klein, 1954); field independence was measured by the group embedded figures test (GEFT, Oltman et al., 1971) and reflective style was measured by the matching familiar figures test (MFFT, Kagan et al., 1964).

Leveller-sharpener style loaded highly on factor one with field independence-dependence; reflective-impulsive style also loaded moderately on the same factor. However, this finding was not replicated in Allinson and Hayes's (1996) factor analysis; in their study, leveller-sharpener style did not load sufficiently with field independent-dependent style and reflective-impulsive style to be included in the analytic-intuitive factor.

### **3.3.2 Convergent-Divergent dimension**

Convergent and divergent thinking measures were not included in Riding and Dyer's (1983) factor analytic study and they did not load sufficiently to be included in Allinson and Hayes's (1996) analytic-intuitive factor. Surprisingly, all the empirical evidence reported by Riding and Cheema (1991) demonstrated a link with field independence and divergent thinking, which is in opposition to their theory. They reported a number of studies linking divergent thinking with field independence

(Bloomberg, 1971; 1976; Noppe and Gallagher, 1977; Spotts and Mackler; 1967). For example; Spotts and Mackler (1967) found some limited evidence that field independent individuals, as measured by the EFT, performed better than field dependent individuals on tests of ideational fluency, flexibility, originality and elaboration.

Riding and Cheema (1991) do not acknowledge this contradiction that on the one hand they proposed that convergent individuals should be at the analytic pole with field independent individuals; and that divergent individuals should be at the wholist pole with field dependent individuals, see Table 3.1; whilst also reporting evidence that indicates the opposite, that field independents are more divergent.

It is also worth noting that, on closer inspection, the Bloomberg (1971) study, reported by Riding and Cheema as supporting a link between divergent thinking and field independence, actually reported no significant relationship between their measures of creativity and field independence. The intention here is not necessarily to point out the error but to highlight the fact that the Bloomberg study used the Rod and Frame test as the measure of field independent-dependent style, not the embedded figures test. It may be that the relationship reported between divergent thinking and field independence, by the studies that employed the EFT, was mediated by ability rather than style. The EFT has been widely criticised as being a measure of fluid ability rather than style (Cronbach, 1970; Cronbach and Snow, 1981; Grigorenko and Sternberg, 1995; Sternberg and Grogorenko, 1997).

More recently Bahar and Hansell (1999) found a weak relationship between field independence and divergent style, which approached significance. Again, the EFT was used as the measure of field independence but in addition to this, the test used to assess divergent thinking in Bahar and Hansell's study required participants to produce a finite number of possible answers, which would have rendered the test a measure of ability rather than style.

Hudson (1967) demonstrated that when completing the object uses test, a test of divergent thinking, the instructions could be manipulated to assess ability or style. When the standard instructions are used, which require participants to produce as many uses for the objects as possible; only 7% of participants generated a minimum of 25 responses. However, when the instructions were manipulated by requesting participants to produce at least 25 uses for the objects, 65% were able to do so.

In summary, there is no evidence linking convergent thinking with field independent, reflective, serialist or sharpener styles and no evidence linking divergent thinking with field dependent, impulsive, holist or leveller styles. The only styles that do consistently demonstrate a relationship are field independent-dependent style and reflective-impulsive style.

### **3.3.3 Field independent-dependent style and reflective-impulsive style**

Messer's 1976 review of reflective-impulsive style, as reported by Riding and Cheema (1991), and Riding and Cheema's own 1991 review uncovered a handful of studies in the early 1970s which directly compared Field independence-dependence with reflective-impulsive style (Banta, 1970; Campbell and Douglas, 1972; Keogh and Donlon, 1972; Massari and Massari, 1973; Schleifer and Douglas, 1973; Massari, 1975; and Neimark, 1975). The purpose of revisiting these studies is to examine the method which measured field independent-dependent style: either the Rod and Frame test (RFT); Embedded Figures Test (EFT); Group Embedded Figures Test (GEFT); or the Childrens' Embedded Figures Test (CEFT).

It will be argued that the CEFT is sensitive to reflective-impulsive style and therefore correlations between the CEFT and the matching familiar figures test (MFFT) do not necessarily support the unitary perspective of style. Three additional studies which

were not reported in Riding and Cheema's (1991) review can be added to this list: Mumbauer and Miller, 1970; Cohen, Weiss and Minde (1972) and Glynn and Stoner (1987); and one more recent study published since their review, Jamieson (1992).

*The relationship between reflective-impulsive style and field independent-dependent style when the CEFT is employed as a measure of field independent-dependent style*

Campbell and Douglas (1972) assessed the field independent–dependent style and reflective-impulsive style of sixty boys, twenty aged six years old; twenty aged eight years old; and twenty aged ten years old, using the CEFT and the MFFT. Field independence significantly correlated with increased MFFT latencies ( $r = 0.25$ ) and greater MFFT accuracy ( $r = 0.45$ ). Campbell and Douglas also used the median split method to identify twenty reflective boys and twenty impulsive boys; they found that the reflective group were significantly more field independent than the impulsive group.

Massari (1975) tested one hundred and fourteen, first and third grade children on the CEFT and the MFFT. The median split method was used to classify participants as reflective or impulsive based on their latency to first response and number of errors on the MFFT. Reflective children were significantly more field independent than impulsive children.

Banta (1970) during the course of developing the Cincinnati Autonomy Test Battery (CATB) revised the MFFT and the CEFT for use with lower class pre-school children. His versions of the MFFT and the CEFT were labelled the Early Childhood MFFT (EC-MFFT) and the Early Childhood EFT (EC-EFT). The stimuli were less demanding, the written verbal instructions were reduced and there was no time limits placed on the tasks or latencies recorded. He found that the EC-MFFT correlated with the EC-EFT ( $r = .49$ ) and with the CEFT ( $r = .27$ ).

Massari and Massari (1973) assessed seventy three, three to five year olds (thirty four males and thirty nine females) using the EC-EFT and the EC-MFFT (Banta, 1970)). The EC-MFFT scored the number of errors to correct solution and the latency to first response and the EC-EFT scored the number of correct solutions and the latency to correct response. Latency to first response on the EC-MFFT and latency to correct response on the EC-EFT significantly correlated ( $r = 0.39$  and  $0.46$ , respectively for boys and girls); the number of errors made before achieving the correct solution on the EC-MFFT and the number of correct solutions on the EC-EFT correlated ( $r = -0.45$  and  $-0.46$  for boys and girls).

Schleifer and Douglas (1973) undertook two studies. The first used twenty-nine children from a middle class background, aged six or seven years old. Field independent –dependent and reflective-impulsive style was measured using the CEFT and the MFFT; correlations between the CEFT and the MFFT were not reported but the children classified as ‘High Level’ respondents in a test of moral judgement were significantly more field independent and had longer latencies to first response on the MFFT but were not significantly more accurate.

The second study used thirty-five middle class children aged three to six years and thirty-seven children from low-income families aged three to six years; style was measured using the EC-EFT and the EC-MFFT. In both samples reflective style correlated with field independence ( $r = 0.62$ ).

Mumbauer and Miller (1970) administered the CEFT and the MFFT to sixty-four children aged between four years eight months to five years eight months. Accuracy on the CEFT and the MFFT correlated ( $r = 0.56$ ) and latencies to first response on the CEFT and the MFFT correlated ( $r = 0.43$ ).

It is clear from this group of studies that when the CEFT is used to measure field independent-dependent style, the relationship between reflective-impulsive style and field independent-dependent style has been consistently reported with reflective individuals being more field independent. Only one study that employed the CEFT reported a non-significant correlation of 0.35 between accuracy on the CEFT and latency on the MFFT (Glynn and Stoner, 1987).

*The relationship between reflective-impulsive style and field independent-dependent style when the CEFT is not employed as a measure of field independent-dependent style*

Keogh and Donlon (1972) tested twenty-seven boys with severe learning disorders aged between eight and fourteen years and twenty-five boys with mild to moderate learning difficulties aged nine to thirteen years. The boys' styles were assessed using the Portable Rod and Frame Test (PRFT) (Gerard, 1969) and the MFFT. The severe learning disordered group were significantly more impulsive than the mild to moderate group, based on MFFT errors and latency scores, but the groups did not significantly differ on field independent-dependent style.

In the mild to moderate learning disordered group reflective-impulsive style was not significantly related to field independent-dependent style; in the severe learning disordered group field independent-dependent style was not related to MFFT latencies but was significantly related to number of errors. However, in the mild to moderate group, errors and latencies on the MFFT significantly correlated ( $r = -0.64$ ) suggesting that longer reflection times led to greater accuracy to first response and errors were a result of a lack of reflection; in the severe learning disordered group error scores did not significantly correlate with latency to first response suggesting that reflective-impulsive style was not mediating accuracy.

Neimark (1975) administered the EFT and the MFFT to eighty-four, third to sixth grade children (forty-four males and forty females) and found that EFT scores correlated with MFFT accuracy ( $r = .46$ ) but not with MFFT latency ( $r = -.19$ ).

Cohen et al. (1972) administered the EFT and the MFFT to forty adolescent boys, comparing twenty participants previously diagnosed as hyperactive with twenty control participants. Hyperactives were more impulsive, with shorter MFFT latencies and less accuracy and more field dependent than the control group. Correlation statistics between EFT and MFFT measures were not reported.

More recently, Jamieson (1992) measured the style of forty-six adult students studying English as a second language, using the GEFT and the MFFT; she found no significant relationship between reflective-impulsive style and field independence-dependence.

In summary, the relationship between reflective-impulsive style and field independent-dependent style has not been satisfactorily demonstrated by the collection of studies that have employed the EFT, the GEFT or the PRFT despite the fact that a consistent relationship has been demonstrated when the CEFT has been used. This can be explained by the different methodology used in the CEFT.

The CEFT (Karp and Konstadt, 1971) was based on the first child friendly version of the EFT, the CHEF, developed by Goodenough and Eagle (1963). To make the task more enjoyable for children, each complex figure is presented as a large jigsaw; several of the pieces have knobs attached to them. The children are shown a simple form and asked to pull out the piece of the jigsaw, which matches it; only one piece matches the simple form. To make the task fun and to ensure that the children perceive the figure as a whole, the jigsaw represents a meaningful figure rather than the abstract shapes used in the original EFT.

The most important difference in the CEFT, in terms of construct validity, is that instead of scoring the latency to production of the correct response as in the EFT, the scoring is based on the latency to the first response, regardless of accuracy. This adaptation was introduced to reduce the childrens' feeling of failure but it fundamentally changes the basis of the measurement. By creating a situation with response uncertainty, providing a fixed set of alternatives and measuring the speed of the first response, the method is the same as that used by Kagan to measure reflective-impulsive style in the MFFT.

Therefore, the consistent relationship between reflective-impulsive style and field independent-dependent style that has been demonstrated between studies, which have employed the CEFT as the measure of field independent-dependent style, may be mediated by the CEFT's sensitivity to reflective-impulsive style and not because of a genuine relationship between the style constructs. This is because both of the style measures are recording latencies to first response in situations of uncertainty when a series of alternative responses are presented.

### **3.4 Chapter summary and conclusions**

Riding and Cheema's (1991) review identified five principal style constructs which they subsumed under the super-ordinate wholist-analytic dimension: holist-serialist style; leveller-sharpener style; convergent-divergent style; reflective-impulsive style; and, field independent-dependent style. The construct validity of the wholist-analytic dimension dictates that the five principal style labels should correlate with each other.

There is, however, no empirical evidence that holist-serialist style correlates with any of the other principal style labels. There is no independent evidence that leveller-sharpener correlates with any of the principal style labels; it did load on the same

factor as field-independent style and reflective-impulsive style in Riding and Dyer's (1983) factor analytic study but this was not replicated by Allinson and Hayes (1996).

There is no evidence that convergent-divergent style correlates with any of the styles, with the exception of field independence-dependence. However, curiously the studies, which have suggested a link with field independent-dependent style, have found a correlation in the opposite direction to that predicted by proponents of unitary style (Miller, 1987; Riding and Cheema, 1991; Ehrman and Leaver, 2003). In each case the field dependent pole has been linked with convergent thinking and the field independent pole with divergent thinking (Bahar and Hansell, 1999; Bloomberg, 1976; Noppe and Gallagher, 1977; Spotts and Mackler, 1967).

The only two principal styles that have demonstrated a consistent relationship are reflective-impulsive style and field independent-dependent style. These two styles loaded on the same factor in both Riding and Dyer's (1983) and Allinson and Hayes (1996) factor analytic studies. In addition, there are ten correlational studies that have considered the relationship between these two styles and seven of them reported a relationship between field independence and reflective style.

However on closer inspection, six of the seven studies, which have reported an association between reflective style and field independence, have used the CEFT as a measure of field independent-independent style. The CEFT is a revised measure of the EFT that was adapted for use with children. It has been argued here that the adaptations reduced the validity of the CEFT and made it sensitive to reflective-impulsive style. The result was that both the CEFT and the MFFT measured the latency to the first response, in a situation of uncertainty in which a respondent was forced to choose from a number of response options. Therefore, correlations between the CEFT and the MFFT may be a result of them both measuring reflective-

impulsive style, rather than evidence for an association between field independent-dependent style and reflective-impulsive style.

The above casts doubt over the only consistent evidence, which has been provided for the unitary perspective and therefore, further weakens the unitary perspective of global-analytic style. On a more positive note, the other common variable amongst the CEFT studies is their use of young children; the relationship between styles may be more readily apparent in very young children.

The unitary perspective rests on the assumption that global-analytic constructs should inter-correlate however, since Riding and Cheema's (1991) review and consolidation of the style literature, very little has been done to test this assumption. Riding (2005) and Hodgkinson and Sadler-Smith (2003) have recommended that a selection of style measurements should be compared to assess their relationship; therefore this thesis will assess four measures of global-analytic style with the aim of testing the unitary assumption. Two super-ordinate measures of style will be assessed, wholist-analytic style (Riding, 1991) and analytic-intuitive style (Allinson and Hayes, 1996); and two principal style measures will be assessed, reflective-impulsive style (Kagan et al. 1964) and convergent-divergent style (Hudson, 1967), see Chapter eleven and twelve.

Since there is no standardised measure of convergent-divergent style, a new measure will be constructed and validated, see Chapter seven. Additionally, a computer presented replication of the matching familiar figures test will be constructed to measure reflective-impulsive style, see Chapter eight.

**Chapter 4:**  
**Methodological Limitations**  
**of the**  
**Wholist-Analytic Ratio**

## **Chapter 4: Methodological limitations of the wholist-analytic ratio**

### **4.1 Chapter Introduction**

A serious shortcoming of the wholist-analytic dimension is that it has not successfully demonstrated that it differentiates between individuals based on their tendency to part or whole process. In chapter two it was demonstrated that studies which manipulate the structure of learning material in a way that is predicted to affect part and whole processors have been inconclusive and a comparison between the wholist-analytic dimension and Navon type tasks requiring local or global processing failed to demonstrate a relationship.

The central concept of wholist-analytic style is that it should discriminate between individuals who organise information in wholes or in parts (Riding, 1991). This chapter will argue that the wholist-analytic dimension is sensitive to aspects of global-analytic style, but does not constitute a valid measure of peoples' ability to part or whole process.

There are a number of methodological limitations with the assessment of the wholist-analytic dimension, which leads to two confounding variables, which reduce its validity. The first limitation is that the wholist-analytic ratio is confounded by individual differences in reflective-impulsive style. The second limitation is a possible asymmetry in the wholist-analytic ratio such that the wholists are assessed on their ability to part process relative to their ability to whole process; but the analytics are assessed on the efficacy of a part processing strategy in a part-processing task relative to a whole processing task.

## **4.2 Sensitivity of the wholist-analytic ratio to reflective-impulsive style**

There is a fundamental methodological limitation with the way the wholist-analytic style ratio is calculated, which confounds the measurement of part-whole processing with individual differences in reflective-impulsive style. This confounding factor is the lack of counterbalancing of the wholist-analytic subtests.

Riding's (1991) Cognitive Styles Analysis (CSA) consists of 3 subtests; the first assesses the verbal-imager dimension; and, the second and third assess the wholist-analytic dimension. Wholist-analytic style is determined by the relative time that individuals take to complete the second subtest in comparison to the third subtest. The second subtest consists of a series of matching figure tasks which requires the respondent to decide if two complex geometric figures are the same or different. The third subtest consists of a series of embedded figure tasks in which the individual has to decide if a given simple geometric shape is contained within a more complex geometric figure.

The matching figures task is assumed to favour whole processing and the embedded figures task is assumed to favour analytic processing; therefore, those who complete the matching figures subtest relatively faster than they complete the embedded figures subtest will be labelled as wholists and vice versa for analytics, and the relative speed of processing each subtest is expressed as a style ratio.

Importantly, the order of presentation of the matching figures and embedded figures subtests is not counterbalanced. Counterbalancing is standard practice when employing repeated measures and there is no methodological or theoretical basis to explain the absence of such measures in the CSA. It will be demonstrated that this limitation has reduced the validity of the ratio method as a measure of the wholist-analytic dimension by confounding the wholist-analytic ratio with reflective-impulsive style.

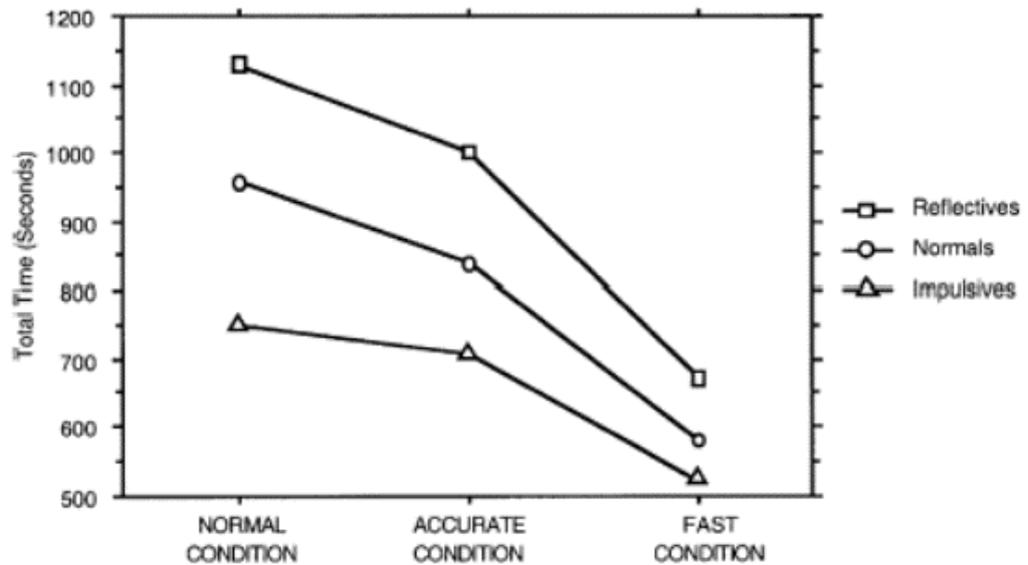
#### **4.2.1 Reflective-Impulsive style and order effects**

Reflective styles are characterised by people who focus on accuracy rather than speed of response, whereas, impulsive people tend to focus on speed to the detriment of accuracy (Kagan et al., 1964). Nietfeld and Bosma (2003) demonstrated that reflective and impulsive characteristics are moderately stable across verbal, mathematic and spatial tasks and are stable across tasks when accuracy is emphasised (accurate response condition), when speed is emphasised (fast response condition) and when neither speed nor accuracy is emphasised (normal response condition).

Nietfeld and Bosma used a sample of fifty-nine undergraduates and found that reflectives produced the slowest and most accurate mean responses across the three response conditions (normal, fast and accurate) and the impulsives were the fastest and the least accurate; the differences between reflectives and impulsives were all significant. The 'Normals', those who were neither reflective nor impulsive, showed the greatest flexibility, they were significantly more accurate than the impulsives in the accurate and fast conditions but not significantly slower and they were significantly faster than the reflectives in the accurate and fast conditions but not significantly less accurate. The lowest accuracy figures and the shortest latencies for all style groups were in the fast condition.

Their findings revealed an order effect: the reflective, normal and impulsive groups were slowest during the first subtest (the normal condition); faster during the second subtest (the accurate condition); and fastest during the third and final subtest (the fast condition).

There was significant interaction between the response conditions and the style groups for latency. Whilst all the style groups had a tendency to increase their speed of processing across the response conditions, the reflective participants increased disproportionately, reducing the processing gap between reflective and impulsives, see Figure 4.1.



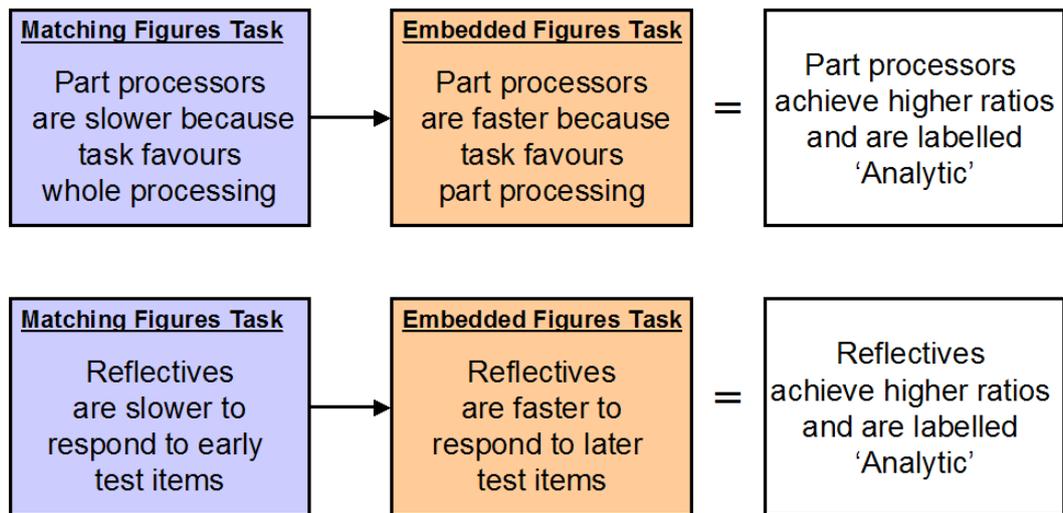
**Figure 4.1: Style group means across response conditions** (*Reproduced with permission from Nietfeld and Bosma, 2003*)

In the normal condition, reflective mean latencies were 379.30 ms slower than the impulsives with an effect size of 2.59; in the accurate condition, reflective mean latencies were 294.13 ms slower ( $d = 1.89$ ); and in the fast condition mean latencies were only 149.75 ms slower ( $d = 1.06$ ). This suggests that the reflective participants began very slowly when approaching the novel task but as the uncertainty surrounding the task diminished, reflective behaviour diminished. This reflective tendency, when combined with the lack of counterbalancing of the wholist-analytic subtests, has serious implications for the validity of the wholist-analytic ratio.

### **4.3 The implications of reflective characteristics and order effects on the wholist-analytic ratio**

In the context of the CSA, this means that the wholist-analytic ratio is measuring reflective-impulsive style not part-whole processing style; or at the very least is measuring both. This confounding variable is a result of the order of presentation of the matching figures tasks and the embedded figures tasks. The matching figures subtest is always presented first, followed by the embedded figures subtest; therefore people with reflective styles will respond more slowly to the matching figure items and increase their speed as they progress through the embedded figure items. This means that reflective people will respond more slowly to the matching figure section relative to the embedded figure section and will therefore be labelled as analytic, see Figure 4.2. This means that individuals may be labelled as analytic because they have a reflective style and not because they have a preferred part processing style.

The sensitivity of the wholist-analytic ratio to differences in reflective-impulsive style is likely to exaggerate individual differences between wholist and analytic participants in a way that is consistent with Riding's theoretical assumptions because analytics are predicted to have both a part processing preference and a reflective style. Therefore, individuals with an analytic style and a reflective style will be slower on the wholist items because they are part processors and because they are approaching early test items with caution, see Figure 4.2, and this will amplify the wholist-analytic ratio.



**Figure 4.2: The effect of part processing preferences and reflective style on the wholist-analytic ratio**

It should be possible to expose the effect of reflective-impulsive style by manipulating the order in which the subtests are presented. It follows that when the matching figures task is presented first, reflective individuals will achieve more analytic ratios; and, when the embedded figures task is presented first, reflective individuals will achieve more wholist ratios.

In addition to the sensitivity of the wholist-analytic ratio to reflective-impulsive style, the second limitation of the wholist-analytic ratio relates to an asymmetry in the way part processing is compared to whole processing in analytics and wholists. The wholist-analytic subtests do not consistently measure the relative ability to perform part and whole processing.

#### **4.4 An asymmetry in the wholist-analytic ratio**

The wholist-analytic dimension is based on the assumption that wholists will perform better (i.e. respond relatively quicker) to matching figures tasks and analytics will perform better (i.e. respond relatively quicker) to embedded figures tasks. This is because their preferred processing style is most suited to the respective task demands. However, Riding (1991; 1998; 2005) does not explicitly state why the wholists or analysts are slower to respond to tasks, which do not compliment their preferred style. There are two possible explanations:

Either, they are slower because they are being forced into using a style, which is not their preferred style; or, they are slower because they continue to use their preferred style even when such a strategy is less efficient for the task at hand?

The implication of Riding's design is that the matching figures task requires whole processing and the embedded figure task requires part processing. If this is correct then the ratio of response times to the wholist and analytic items is measuring an individual's speed of whole processing the matching figure items versus the speed of part processing the embedded figure items. Therefore, in this scenario there is symmetry in the way the processing of wholists and analytics is being compared by the ratio; wholists are those who are faster at whole processing and slower at part processing and analytics are those who are faster at part processing and slower at whole processing.

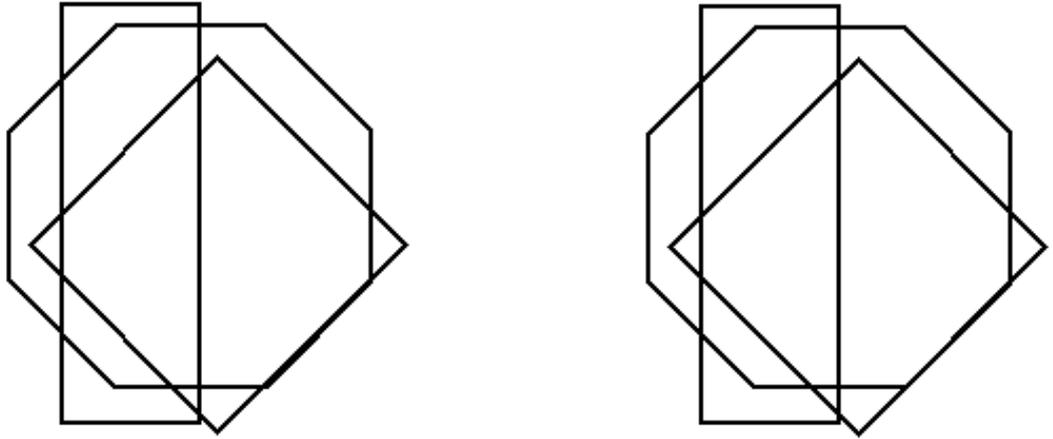
**Table 4.1: Symmetry in processing**

	<b>Strategy employed by a Wholist Individual</b>	<b>Strategy employed by an Analytic Individual</b>
<b>Matching Figure Tasks</b>	Whole processing	Whole processing
<b>Embedded Figure Tasks</b>	Part processing	Part processing

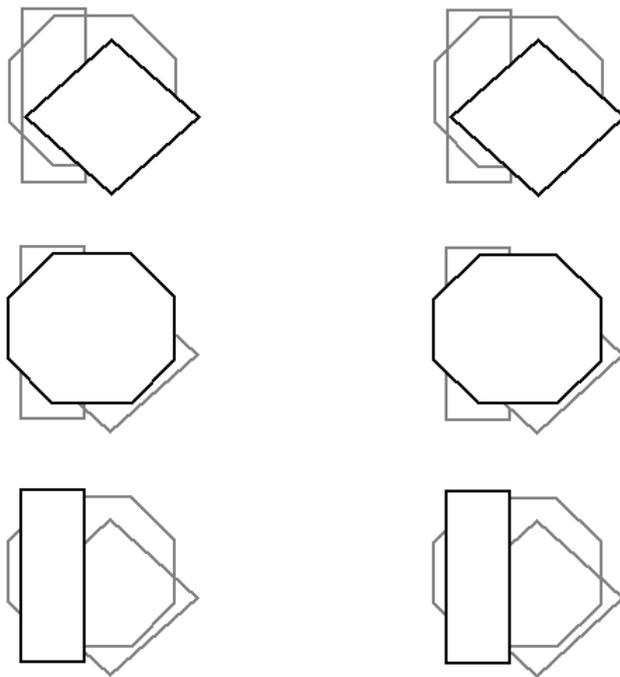
However, in practice either a part or a whole processing strategy may be used to complete the matching figure task but only a part processing strategy can be used to complete the embedded figure task.

#### **4.4.1 Strategy choice and the matching figure task**

The matching figure task may be processed using a whole processing strategy or a part processing strategy. Whole processing would involve treating each figure as a whole and assessing the degree of similarity between gestalts, see Figure 4.3; and a part processing approach would involve attending to each simple shape within the first complex figure and assessing the similarity with each of the shapes within the second complex figure, see Figure 4.4.



**Figure 4.3: Matching figures - whole processing strategy**

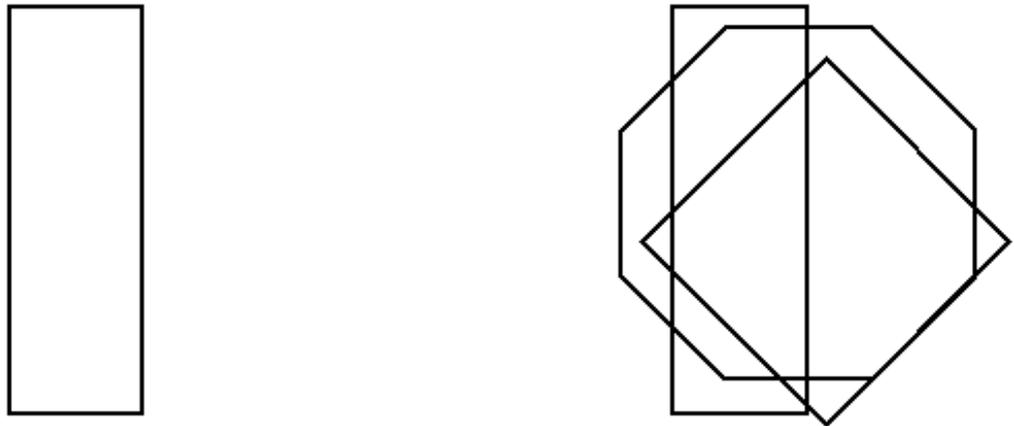


**Figure 4.4: Matching figures - part processing strategy**

When completing matching figures tasks a whole processing strategy will be more efficient than a part processing strategy. However, unlike the matching figures task, the embedded figures tasks can only be approached using one processing style.

#### **4.4.2 Strategy choice and the embedded figures task**

The very nature of the embedded figure task requires that a part processing strategy must be used and rules out the option of using a whole processing strategy, see figure 4.5.



**Figure 4.5: Embedded figures – part processing strategy**

#### **4.4.3 Effect of strategy choice on the wholist-analytic ratio**

Since the matching figures tasks can be completed using part processing or whole processing but the embedded figures tasks can only be completed using part

81

processing, this would lead to an asymmetry in the nature of the processing being calculated by the wholist-analytic ratio. The asymmetry is illustrated in the following scenario:

An individual has the ability to use both whole and part processing strategy, but will employ their style preference if the task allows. Therefore, a part processor will use part processing to complete both tasks because it is their preferred style whereas the whole processors will use whole processing for the matching figures task but will be forced to use part processing for the embedded figures task, see Table 4.2.

**Table 4.2: Asymmetry in processing**

	<b>Strategy employed by a Wholist Individual</b>	<b>Strategy employed by an Analytic Individual</b>
<b>Matching Figure Tasks</b>	Whole processing	Part processing
<b>Embedded Figure Tasks</b>	Part processing	Part processing

Therefore, in this scenario there is an asymmetry in the way the processing of wholists and analytics is being compared by the ratio; wholists are those who are faster at whole processing and slower at part processing; and, analytics are those who are faster at embedded figures items than matching figure items because part processing is a more efficient strategy for embedded figures tasks.

If the postulated asymmetry exists, the wholist-analytic ratio will still be sensitive to processing differences between wholist and analytic individuals but the ratios being compared cannot be assumed to be measuring directly comparable differences. It should be possible to expose these differences by manipulating the number of constituent parts in the complex figures, which form the basis of the wholist-analytic tasks. It follows that when part processing is employed, processing times should get longer when more parts have to be processed.

#### **4.5 Chapter summary and conclusions**

This chapter has proposed two methodological limitations of the wholist-analytic ratio that raise doubts over its validity. The first limitation, and perhaps the most serious, is the sensitivity of the ratio to reflective-impulsive style differences. It has been proposed that reflective individuals will be labelled as analytic based on their reflective characteristics rather than because they have a preference for part processing. The wholist-analytic ratio is confounded in this way because of the order effects, which result from a lack of counterbalancing of the matching figures and embedded figures subtests.

The second limitation concerns the use of part and whole processing strategies for completion of the matching figures and embedded figures tasks. It has been argued that either strategy may be used to complete the matching figure tasks but only a part processing strategy can be used to complete the embedded figure tasks. When this is combined with the notion that respondents will habitually choose their preferred style of processing where possible, it sets up an asymmetry in the strategies used by analytics and wholists.

Part processors will employ part processing for both tasks but will be relatively slower at the matching figures task because it is less suited to a part processing

strategy; part processors will therefore be labelled as analytics because of a strategy-task mismatch. Whereas, whole processors will employ whole processing for the matching figures task and part processing for the embedded figures task; they will be slower at the embedded figures task because they are slower at part processing; whole processors will therefore be labelled as wholist because of their relative ability to whole or part process.

In order to demonstrate the sensitivity of the wholist-analytic ratio to individual differences in reflective-impulsive style and to examine the proposed asymmetry in the nature of part and whole processing differences in the wholist-analytic ratio, a new measure of wholist-analytic style, the Wholist-Analytic Style (WAS) Analysis, has been developed which represents a partial replication of the wholist-analytic subtests of the CSA. The measure is designed as a tool to expose the limitations of the wholist-analytic ratio not as an alternative measure. The construction and methodology of the WAS analysis is described in full in Chapter six.

Two versions of the wholist-analytic styles analysis (WAS analysis) have been developed; one version, the WAS-WA presents the matching figures subtest and the embedded figures subtest in the same order as it is presented in the CSA; the other version, the WAS-AW, reverses the order of subtest presentation. A comparison of the ratios produced by each version of the WAS analysis will expose the effects of reflective-impulsive style on the wholist-analytic ratio.

The limitations of the wholist-analytic dimension outlined in this chapter lead to reduced validity of the wholist-analytic ratio; however; the confounding effects of reflective-impulsive style can also explain the low temporal reliability of the wholist-analytic dimension which has been widely reported in the literature (Parkinson, Mullally and Redmond, 2004; Peterson, Deary and Austin, 2003; Rezaei and Katz, 2004; Cook, 2008). A review of the reliability and an explanation of low reliability will be discussed in Chapter five.

**Chapter 5:**  
**An Explanation for the Low Reliability**  
**of the**  
**Wholist-Analytic Dimension**

## **Chapter 5: An explanation for the low reliability of the wholist-analytic dimension**

### **5.1 Chapter introduction**

The wholist-analytic dimension in its present form has low test-retest reliability (Peterson et al., 2003; Parkinson et al., 2004; Rezaei and Katz, 2004; Cook, 2008). Parkinson et al., (2004) administered the CSA to fifty-one students with a two-week test retest interval, reporting a correlation of 0.33 for the wholist-analytic ratio. They also administered the CSA to a further sample of twenty-seven students, over a twenty three-month interval, producing a correlation of 0.34. Cook (2008) tested eighty-nine medical residents and students, with an average test-retest interval of 18 months, producing a correlation of 0.30. Rezaei and Katz (2004) used test retest intervals of one week and one month and varied the emphasis of accuracy over speed producing reliability coefficients of 0.42, 0.45 and 0.55.

Modified forms of the CSA have also demonstrated low temporal reliability for the wholist-analytic dimension with coefficients of 0.30 and 0.31 using a one-week interval (Peterson et al., 2003a). Better temporal reliability figures ( $r = 0.53$ ) were achieved by combining a replica and a parallel form of the CSA to create an extended eighty-item test (Peterson et al., 2003a).

An atypically high test-retest reliability correlation of  $r = .71$  was produced by Waring and Evans (2003); however, their sample was very small consisting of 18 people and all were trained in the theory and application of cognitive style in the intervening test period which introduced the effect of demand characteristics.

Riding (2003) concedes that the reliability of the CSA should be examined but has argued that whilst reliability is convenient and desirable, it is validity, not reliability,

which is the most important quality in any measurement. In support of this view Riding describes a situation, using the example of the startle test, in which a measure can be valid but not reliable.

It is, of course, theoretically possible for a measure to be valid without having temporal reliability, however, in such a situation the least that should be expected is a theoretical or methodological explanation for the lack of stability. To use Riding's example of the startle test, the startle effect will clearly diminish if the test is administered on subsequent occasions because the startle test by its nature requires naivety. However, Riding provides no theoretical reason why wholist-analytic ratios should not remain stable across testing sessions, after all cognitive styles are theorised to be stable characteristics (Riding, 1991).

Peterson et al. (2003) and Rezai and Katz (2004) have made some effort to improve the temporal reliability of the wholist-analytic dimension by increasing the number of test items, varying the test retest intervals and modifying the test instructions but neither have provided a satisfactory explanation for the lack of temporal reliability.

This chapter offers an explanation for the low temporal reliability, which is based on the validity problems outlined in the previous chapter. In particular, the postulated sensitivity of the wholist-analytic ratio to reflective-impulsive style predicts that participants with a reflective style will produce lower, more wholist ratios at the second sitting of the CSA because the task does not involve the uncertainty associated with the first sitting. This sensitivity to reflective-impulsive style will have the effect of lowering the test-retest reliability correlations of the wholist-analytic dimension.

## 5.2 Temporal reliability of the wholist-analytic dimension

Peterson et al. (2003) produced replica (CSA-A) and parallel versions (CSA-B) of the CSA. This approach was used because Ridings CSA is not open to analysis of internal stability, but the use of a modified version of the CSA in this way has received criticism; Riding (2003) and Redmond, Parkinson and Mullally (2007) have argued that reliability studies should employ unmodified versions of the test they purport to study and that Peterson's version of the CSA is significantly different to the original. Peterson, Deary and Austin (2007) argued that the CSA-A is a replica version of the CSA, which employs the same methodology and stimuli and therefore does not differ in any meaningful way. Riding has also criticised the one week test retest interval employed in Peterson's study; this does appear to be very short and it seems likely that participants will be primed for the words and associations used in the verbal-imagery items. It seems less likely that the short interval would influence the subsequent processing of the figural items in the wholist-analytic sections and Peterson et al's reliability statistics (0.30 and 0.31) were consistent with those found by Cook (2008) with an interval of 18 months ( $r = 0.30$ ) and Parkinson et al. (2004) with intervals of two weeks and twenty-three months ( $r = 0.33$  and  $0.34$ ), both Cook and Parkinson et al. used unmodified versions of the CSA.

Peterson et al (2003) produced improved reliability figures ( $r = 0.53$ ) when the responses to the CSA-A and the CSA-B were combined to become the C-CSA. This was a post hoc manipulation so the reliability ratio derived from the C-CSA was based on repeated exposure to the wholist-analytic order of subtest presentation. Respondents completed twenty matching figures tasks followed by twenty embedded figures tasks (CSA-A) then they had a 5 minute break followed by another twenty matching figures tasks and twenty embedded figures tasks (CSA-B). Presentation order of the CSA-A and CSA-B was counterbalanced but the order in which matching figure and embedded figure trials was not.

The highest reliability figures have been reported by Rezaei and Katz (2004), they used an unmodified version of the CSA on three student samples. Sample 'one' consisted of seventy-three randomly selected high school students, using a test-retest interval of one week. Sample two and three consisted of thirty-six and forty-five volunteer students, respectively, using a test-retest interval of one month. The standardised written instructions also varied such that accuracy was emphasised in samples one and two, whereas, overall speed of response was emphasised in sample three. The lowest coefficient was obtained when a one-week interval was used ( $r = 0.42$ ), this improved as the interval increased to one month ( $r = 0.45$ ) and improved further when reaction time was emphasised ( $r = 0.55$ ).

Unfortunately it is not clear whether Rezaei and Katz's correlation coefficients are based on the stability of the wholist-analytic ratios or the consistency with which individuals were labelled as wholist, intermediate or analytic. In the absence of a statement to the contrary it will be assumed that the statistics are based on the relationship between ratios. However, it is worth noting that Peterson et al's coefficients increased from 0.30 to 0.34 for the CSA-A when labels were used and Parkinson et al's coefficients increased from 0.33 to 0.45 and from 0.34 to 0.54 when correlations were based on allocation of labels rather than ratios. Conversely, test-retest reliability dropped from 0.31 to 0.23 for the CSA-B and from 0.53 to 0.38 for the C-CSA when labels were used.

Whether Rezaei and Katz's correlations are based on ratios or labels, they still report an improvement in temporal reliability when speed is emphasised. Rezaei and Katz offer no explanation for the effect of manipulating the test instructions.

The current thesis offers an explanation for the low temporal reliability of the wholist-analytic dimension (Peterson et al, 2003a; Parkinson et al, 2004; Rezaei and Katz, 2004; Cook, 2008) and explains why repeating the exposure to the wholist and analytic subtests will lead to better stability (Peterson et al., 2003a) and why the

stability improves when the instructions are manipulated to emphasise speed (Rezaei and Katz, 2004). These findings can all be accounted for by considering the sensitivity of the wholist-analytic ratio to reflective-impulsive style that was theorised in the previous chapter.

### **5.2.1 The diminishing effect of reflective style on temporal reliability**

The sensitivity of the wholist-analytic ratio to individual differences in reflective-impulsive style, which was theorised in Chapter four, will diminish with subsequent test sessions. This is because the characteristic tendency of reflective individuals to be slow and cautious during early test items is based on their attempts to ensure accuracy in situations of uncertainty. In the second test, prior experience of the trials leads to reduced uncertainty and a diminished effect of reflective style. The diminishing effect of reflective style will reduce the stability of the ratios between the test and retest sessions.

In Riding's CSA and Petersons CSA-A and CSA-B, which present the matching figure trials first followed by the embedded figure trials; participants with a reflective style and participants with a part processing style will be slowest during the matching figure test items at the first test session and will therefore produce analytic ratios. Since part processing styles and reflective styles are assumed to be related (Riding and Cheema, 1991), reflective-part processors will produce inflated analytic ratios at the first test session owing to the influence of their part processing style and their reflective style.

At the second test session the effect of reflective style will diminish, part processors will still produce analytic ratios but the ratios will not be inflated by concomitant reflective style characteristics. Therefore, those who were labelled as analytic at the first session because of their complimentary reflective and part processing style will

produce lower wholist-analytic ratios at the retest session because the retest ratio will be based on their part processing style and not on their reflective style.

It is hypothesised that by reversing the order of the subtests this effect could be further illustrated. If the embedded figures subtest were presented first, reflective individuals will be slower at the embedded figures tasks because these tasks appear at the beginning of the test and part processors will be slower at the matching figures items because these items are more suited to whole processing. Consequently, the concomitant tendency to be both reflective and a part processor are in conflict.

This means that many of the participants labelled as wholists at the first sitting are actually reflective individuals who were relatively slower at the embedded figure items than the matching figure items because the embedded figures trials were presented earlier in the test, and not because of differences in whole or part processing tendencies. The influence of reflective style will again diminish at the retest session and the reflective individuals, who had previously been labelled as wholist, will produce more analytic ratios because their concomitant part processing style is no longer in conflict with their reflective style.

Therefore it is hypothesised that when the matching figure subtest is presented first, the diminishing effect of reflective style will cause analytic individuals to produce lower analytic ratios at retest. Whereas, if the embedded figure subtest were presented first, the diminishing effect of reflective style will have a greater impact on stability because reflective individuals will swing from producing wholist ratios to producing analytic ratios.

This theory can also account for the relatively higher temporal reliability of Petersons C-CSA. This extended eighty-item test presents the wholist and analytic subtests twice by combining the replica form CSA-A and the parallel form CSA-B. If a respondent completes the CSA-A first and then after a 5 minute break completes

91

the CSA-B then the CSA-A is likely to be influenced by reflective style as described above and this effect will be diminished in CSA-B because the response uncertainty has diminished. This could account for the lack of relationship reported by Peterson between the CSA-A and the CSA-B ( $r = 0.07$ ). When the two modified forms of the CSA are combined to form the C-CSA, the combined measure is less influenced by the effect of reflective style at the first test session and will therefore produce improved correlations at retest.

This theory explains the reported lack of test retest reliability of the wholist-analytic dimension and modified versions of the CSA such as the CSA-A and the CSA-B. It has accounted for the improvement reported in the stability of the C-CSA and can also account for the improvements in stability reported by Rezaei and Katz (2004) when speed was emphasised.

### **5.2.2 Improvement in stability when speed is emphasised**

Rezaei and Katz (2004) reported the highest test-retest reliability when speed was emphasised at the outset of the CSA. This verbal instruction to focus on speed is likely to temper the standardised computer presented instructions at the beginning of the wholist subtest that state “work carefully to ensure accuracy”.

The CSA’s instructions, which encourage caution and accuracy, will reinforce reflective tendencies to carefully consider each response to ensure accuracy. The additional verbal instructions, which emphasise speed, which were introduced by Rezaei and Katz, will to some extent reduce reflective tendencies and speed up their rate of responding.

In effect, Rezaei and Katz reduced the influence of reflective style at the first test session, which increased the consistency of response at retest thereby improving the

temporal reliability. Any changes to the CSA, or modified versions of the CSA, which reduce the influence of reflective-impulsive style would be expected to produce higher test-retest reliability coefficients.

### **5.2.3 Chapter summary and conclusions**

In this chapter it has been hypothesised that the theory of diminished reflection proposed in Chapter four explains the lack of stability, which has been reported in the literature. It predicts the low temporal reliability of any measure of wholist-analytic dimension that fails to counterbalance the matching figure and embedded figure subtests. The theory has also provided an explanation for the improved temporal reliability achieved by Peterson et al.'s (2003) C-CSA and Rezai and Katz (2004). In each case the modifications to the methodology of the CSA served to reduce the influence of reflective style at the first subtest, thereby increasing the stability between test and re-test.

The effect of diminished reflection on temporal reliability will be examined in Chapter ten by performing test-re-test studies on both versions of the newly constructed WAS Analysis, which have been previously discussed in Chapter four and developed and validated in Chapter six.

**Section II.**

**Construction, Development and Validation  
of the  
Cognitive Style Measures**

**Chapter 6:**

**Construction, Development and Validation**

**of the**

**Wholist-Analytic Style (WAS) Analysis**

## **Chapter 6: Construction, Development and Validation of the Wholist-Analytic Style (WAS) Analysis**

### **6.1 Chapter Introduction**

The Wholist-Analytic Style Analysis, or WAS Analysis, is based on the wholist-analytic dimension of the CSA and measures the ratio of the median speed of processing matching figure tasks to the median speed of processing embedded figure tasks. Matching figure items require participants to identify whether two complex figures are the same or different and the embedded figure items require participants to identify whether a simple shape is embedded within a complex figure. Wholists are those who respond relatively faster to matching figure tasks and analytics are those who respond relatively faster to the embedded figures tasks.

The WAS analysis was designed and administered using E-prime (Psychology Software Tools, Inc., Pittsburgh, PA); two version were designed in order to experimentally manipulate the order of the subtests, see 6.1.1. As a matter of good practice, example items have been added to the beginning of each subtest, see 6.1.2; these were not used in the CSA but it will be argued that inclusion of these should reduce hesitancy and inaccuracy during early test items. The instructions contained within the WAS analyses were a partial replication of those used in Ridings wholist-analytic subtests with the exception of instructions relating to speed and accuracy.

The WAS Analyses correct a bias which exists in Riding's CSA which encouraged caution during the matching figures tasks but not during the embedded figures tasks, see 6.1.3; empirical evidence suggests that performance on the wholist-analytic dimension is sensitive to changes in the emphasis on speed versus accuracy (Rezaei and Katz, 2004) and those with reflect-impulsive styles may be most affected by the

presence of instruction bias relating to speed and accuracy (Nietfeld and Bosma, 2003).

Finally, WAS analyses have manipulated the number of simple geometric shapes which are used in the construction of the complex figures utilised in the matching figure tasks and the embedded figure tasks. The complex figures either consists of three simple shapes, which preserve the number of shapes used in Riding's CSA (1991) and Peterson et al.'s C-CSA (2003) and Peterson and Deary's E-CSA (2006); or they consist of five simple shapes.

The increased numbers of parts which make up the whole figure are theorised to increase the response latencies of individuals using part processing but will not affect the individuals employing whole processing, see 6.1.4. The manipulation of the three and five-part figures is designed to expose the nature of processing being employed by the analytics and the wholists during matching familiar figures tasks.

### **6.1.1 Counterbalancing the wholist-analytic subtests**

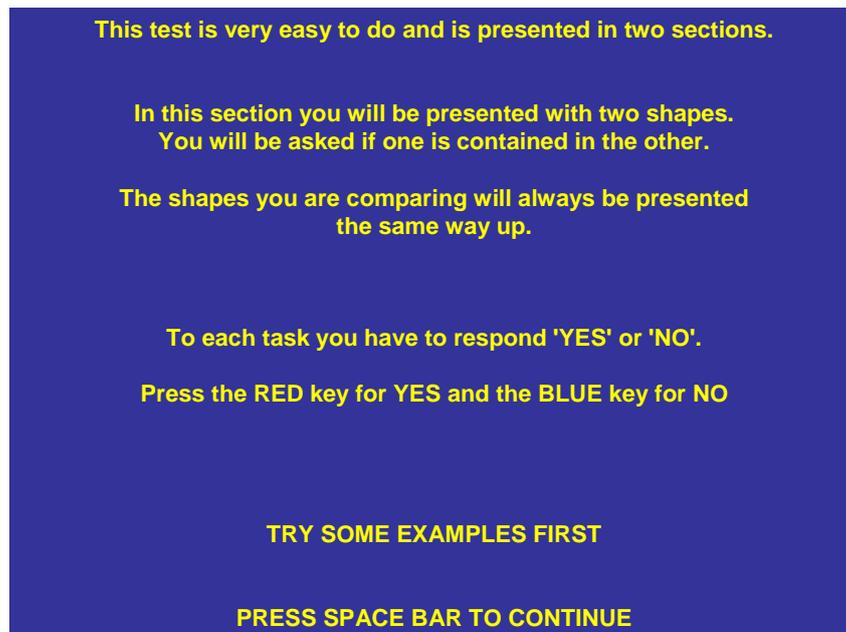
There are two versions of the WAS analysis; each version differs only in respect to the order in which the matching figure subtest and the embedded figure subtest are presented. The first version, which is referred to as the WAS-WA, presents the matching figure subtest first, followed by the embedded figures subtest, thereby preserving the presentation order of Riding's CSA (1991) and Peterson's extended CSA (C-CSA, Peterson et al., 2003; E-CSA, Peterson and Deary, 2006). The second version, which is referred to as the WAS-AW, presents the embedded figures test first, thereby reversing the order of the CSA, the C-CSA and the E-CSA.

The two versions of the WAS Analysis will expose the interaction between the influence of reflective-impulsive style and the order effects created by the lack of

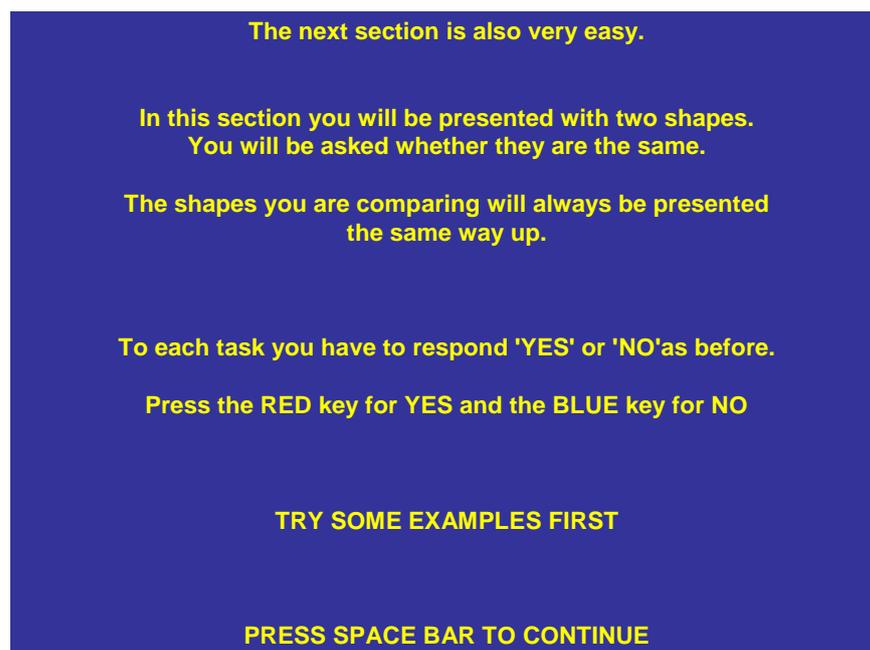
counterbalancing of the wholist-analytic subtests. Chapter four argued that reflective individuals begin more slowly during early test items, in response to the novelty and uncertainty and in an effort to ensure accuracy. Therefore, Reflective individuals should produce higher, more analytic ratios, when the matching figures tasks are presented first; and, lower, more wholist ratios, when the embedded figures tasks are presented first.

### **6.1.2 Practice items**

It is good practice for any psychometric test to have example items prior to the commencement of the trials. This is even more important when the trials are measured on speed and accuracy of processing. In the context of the CSA it is doubly important because any hesitancy in the early test items will influence the wholist-analytic ratio. In the light of this, the WAS Analyses include four practice items prior to each subtest, two of the items are examples of complex figures containing three simple shapes and two are examples of complex figures containing five simple shapes. One of each of the three and five part examples requires a ‘yes’ response and the one of each requires a ‘no’ response. Figures 6.1 and 6.2 show the instructions presented prior to the practice items in the embedded figure subtests and the matching figure subtest, respectively.



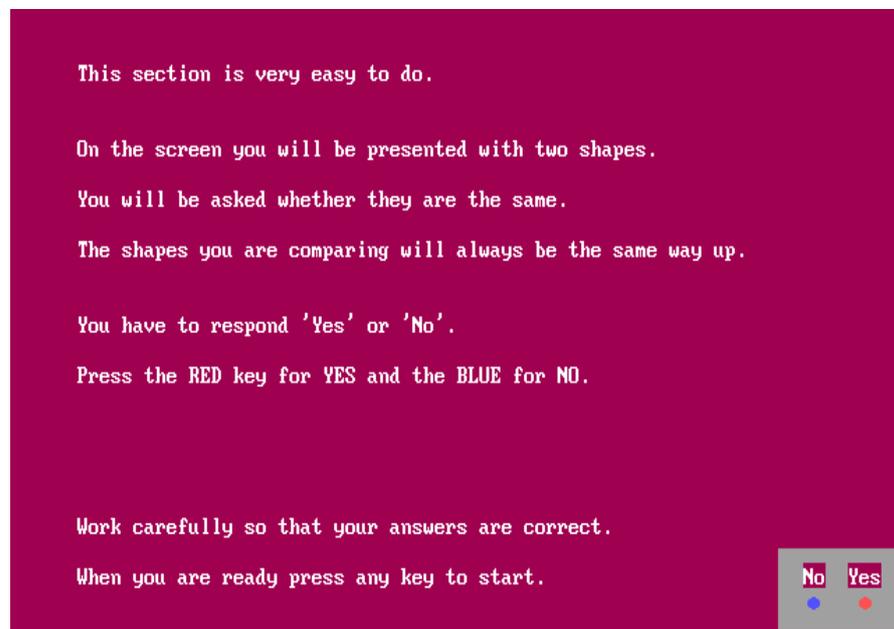
**Figure 6.1: WAS analysis – Embedded figure practice instructions**



**Figure 6.2: WAS Analysis – Matching Figure Practice Instructions**

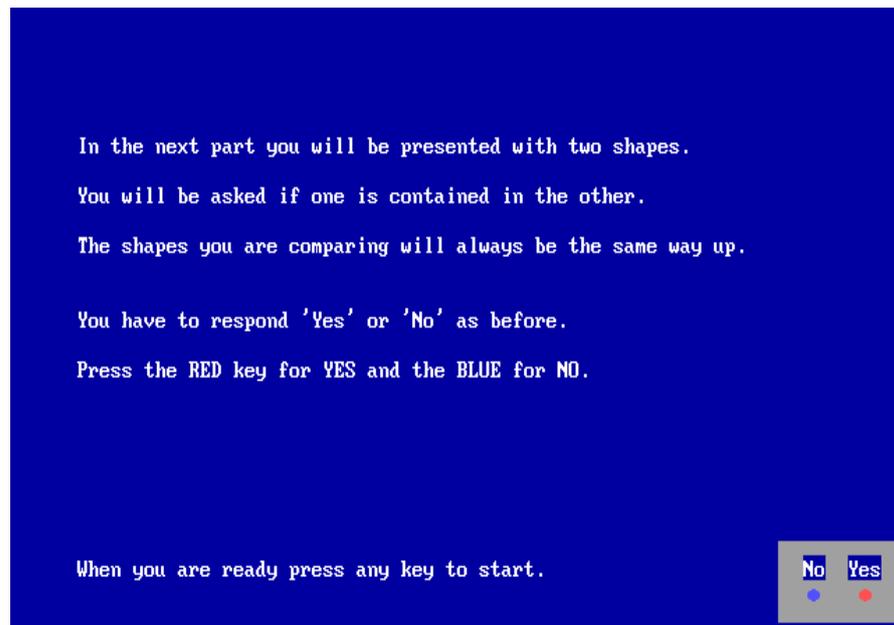
### 6.1.3 Instruction bias

Where appropriate the WAS analyses have replicated the instructions used in the CSA. However, the CSA encourages caution and a focus on accuracy at the beginning of the wholist-analytic subtest but not at the beginning of the analytic subtest. Figure 6.3 shows the instructions presented in the CSA prior to the matching figure subtest; note that the instructions state, “Work carefully so that your answers are correct”.



**Figure 6.3: CSA – Matching figure subtest Instructions**

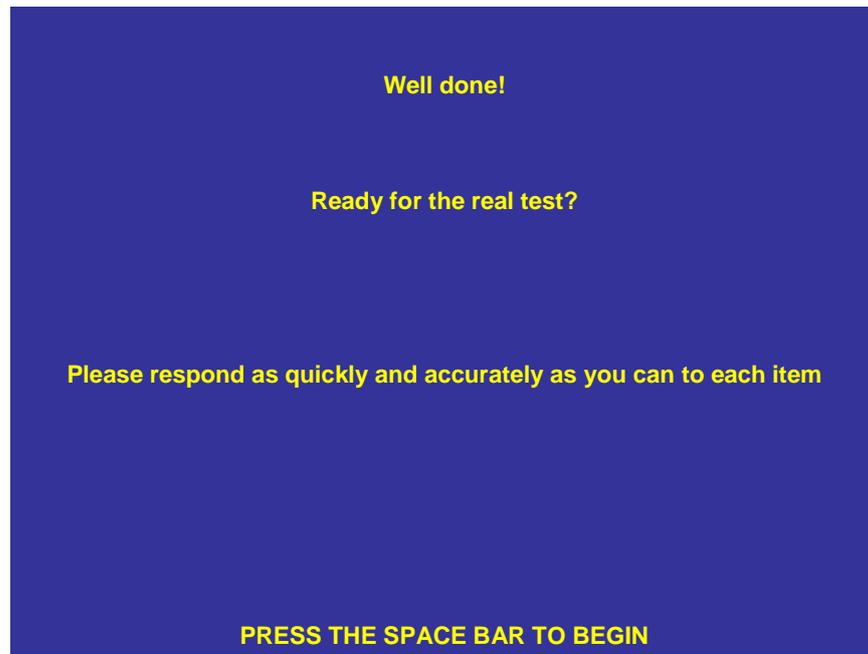
Compare this to the instructions provided prior to the embedded figures tasks, which make no reference to caution or accuracy, see Figure 6.4



**Figure 6.4: CSA – Embedded Figure Subtest instructions**

The bias towards emphasising caution in the early matching figure items and not emphasising caution in the latter embedded figure items is likely to encourage respondents to produce slower median latencies to the matching figure tasks in comparison to the embedded figures tasks which will inflate the their wholist-analytic ratios, making them appear more analytic.

This bias has been corrected in the WAS Analyses and replaced with consistent instructions which emphasise accuracy and speed across both subtests. The instructions in Figure 6.5 appear after the practice items in each section and are identical for both subtests.



**Figure 6.5: Pace and Accuracy Instructions**

#### **6.1.4 Asymmetrical processing comparisons**

The WAS analyses have also been designed to empirically test the nature of processing used by analytic and wholists when completing the embedded figures tasks and the matching figures tasks.

It has been argued, in Chapter four, that the embedded figures task can only be completed using part processing but that the matching figures task allows a choice of either whole or part processing; where such a choice exists it is anticipated that part processors and whole processors will habitually employ their preferred style. As a result, there will be an asymmetry in the nature of processing being measured by the wholist-analytic ratio. Wholists will be compared on their relative ability to use a part or whole processing strategy, since they will employ whole processing for the

matching figure items but will be forced to employ part processing for the embedded figure items. However, analytics will be compared on the efficacy of a part processing strategy when applied to the matching figures task compared to an embedded figures task.

In order to clarify the nature of processing employed during the tasks, the WAS analyses include a manipulation of the number of constituent shapes which make up the complex figures in the matching figures and embedded figures tasks. Half of the complex geometric figures are constructed using three simple shapes and half are constructed using five simple shapes.

It is expected, that the increased difficulty level, which will be associated with processing the five-part figures, will increase the processing latencies of five-part figures in comparison to 3-part figures but over and above this effect of increased complexity there is expected to be a differential effect on part processors over whole processors. This is because part processing a five-part figure will take longer than part processing a three-part figure because every extra part that needs to be separately processed demands extra processing time. However, whole processing a five-part complex figure should not take proportionately longer than processing a three-part figure because there is still one gestalt being compared with another.

Part processors should be slowed down relatively more than the whole processors when faced with a matching task containing five-part figures in comparison to the same task with three-part figures. It follows then that when the relative speed of processing five-part to three-part matching figure tasks is computed, those with a greater differential speed of processing can be assumed to be part processors and those with a smaller differential can be considered whole processors.

### **6.1.5 Part-Whole Processing Ratio**

Based on the rationale above the ratio of speed of processing five-part matching figures to speed of processing three-part matching figures will be computed and used as an index of part-whole processing which is free from the confounding influence of reflective style that reduces the validity of the wholist-analytic ratio. Concurrent and differential validity of the part-whole ratio dictates that analytic individuals should produce lower ratios indicative of part processing and wholist individuals should produce higher ratios indicative of whole processing.

To assess the construct validity of the part-whole ratio; a second ratio will be computed from the completion of the five-part embedded figures and three-part embedded figures tasks. Since it has been argued that embedded figure tasks require part processing there should be no significant difference between the analytic and wholists participants on the ratios computed from the embedded figure subtest. This is because all participants will be employing part processing and are therefore all similarly affected by an increase in the number of parts that require processing.

The part-whole ratio is not proposed as a viable alternative to the wholist-analytic ratio; it is a tool designed to expose the asymmetry in the wholist-analytic ratio. If the part-whole ratio successfully discriminates between analytic and wholist styles and its construct validity is demonstrated, as outlined above, then it confirms the existence of an asymmetry in the basis of the wholist-analytic ratio.

The part-whole ratio only continues to discriminate between analytic and wholist style whilst the asymmetry exists; the aim should be to eradicate the asymmetry to improve the validity of the wholist-analytic ratio.

This chapter first outlines the construction of the WAS analyses based on the rationale set out above and then presents two studies undertaken during the

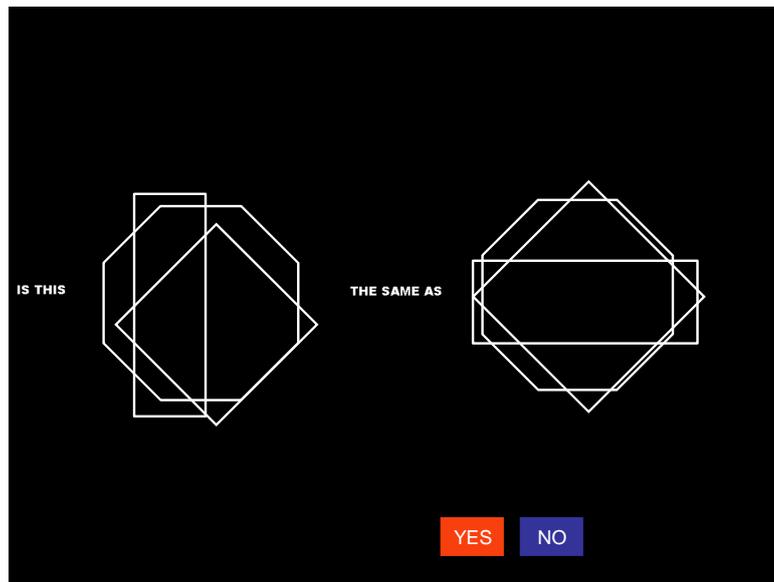
development and validation of the WAS analysis. Both studies assessed the psychometric properties of the WAS analysis; the first addressed the concurrent validity of the WAS analysis with the CSA and the second addressed the internal consistency of the WAS Analysis and the construct validity of the part whole ratio.

## **6.2 Construction of the WAS Analysis**

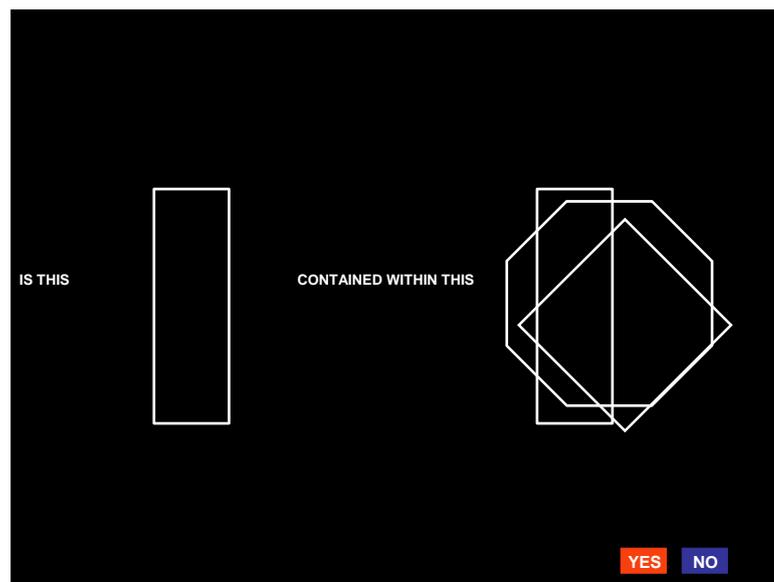
The WAS Analysis has two subtests; the matching figures subtest and the embedded figures subtest. There are forty matching figures tasks and forty embedded figures tasks and in each subtest, twenty items present complex figures that consist of three simple shapes and twenty present complex figures that consist of five simple shapes. Half of the test items require a ‘yes’ response and half require a ‘no’ response, these are counterbalanced across the matching figure and embedded figure subtests and across the manipulation of three and five-part figures.

Riding’s CSA (1991) used only complex figures with three constituent parts, and each subtest consisted of twenty matching figures and twenty embedded figure items, respectively. The WAS analysis preserves the number of three-part figures to allow statistical comparisons and to highlight any systematic differences which may exist between ratios produced by more complex stimuli. The WAS analysis, therefore, uses double the number of test items in the inclusion of five- part figures. Despite this the WAS analysis is still of similar overall length to the CSA because the CSA includes a section to assess the verbaliser-imager dimension and it is the same length and Peterson et al’s extended CSA (2003; 2006)

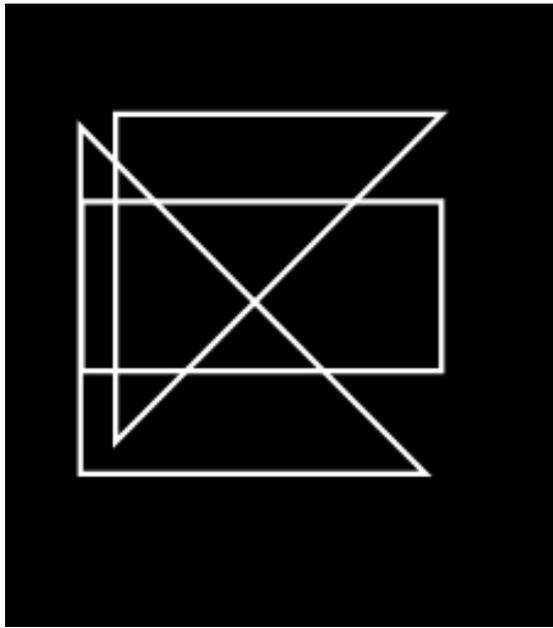
Figures 6.6 and 6.7 show examples of a matching figure item and an embedded figure item from the WAS analysis, each featuring complex figures made up of three simple shapes. Figures 6.8 and 6.9 show an example of a three-part complex figure compared to a five-part complex figure



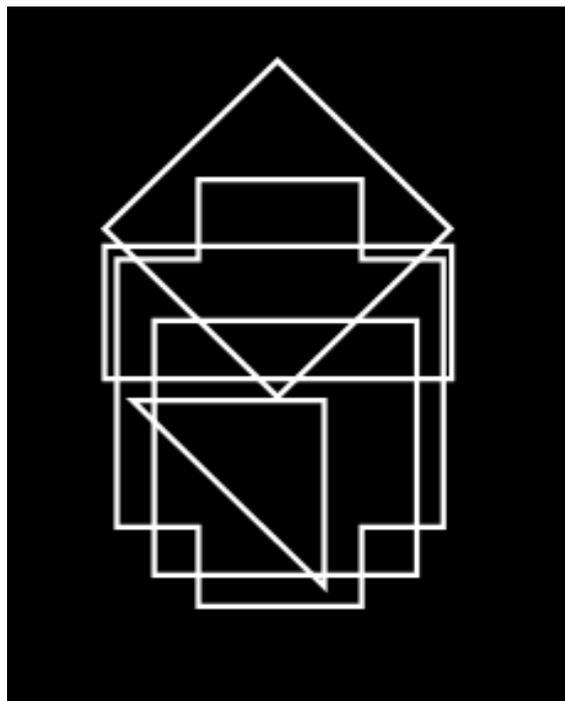
**Figure 6.6: Example of a matching figure item**



**Figure 6.7: Example of an embedded figure item**



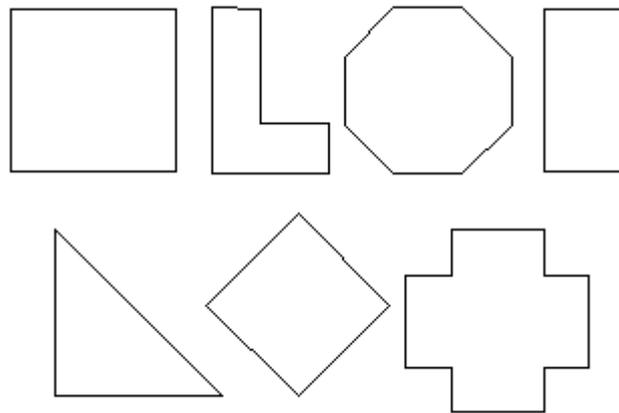
**Figure 6.8: Three-part complex figure**



**Figure 6.9: Five-part complex figure**

### 6.2.1 Stimuli shapes and construction of complex figures

A pool of seven simple shapes have been used to construct all of the complex figures, see figure 6.10, these shapes are the same as those used for the CSA. To remain consistent with the CSA the simple shapes appear in large or small form and can be oriented up, down, left or right. Each complex figure was constructed by first selecting the shape then the size and finally the orientation of each constituent part. Shape, size and orientation were selected randomly with replacement.



**Figure 6.10: Simple shapes used to construct complex figures**

### 6.3 Concurrent validity of the WAS Analysis

The WAS analysis has been developed as a tool to test two hypotheses about the nature of processing being measured by the wholist-analytic dimension. Whilst the WAS analysis differs in a number of ways to the wholist-analytic subtests of the CSA; the revisions should not fundamentally alter the basis of the wholist-analytic style calculation. Therefore, the WAS analysis should demonstrate concurrent validity with the wholist-analytic dimension of the CSA, but only when subtest order

is preserved. Only the WAS-WA version of the WAS Analysis is expected to have concurrent validity with the wholist-analytic dimension of the CSA because this is the version of the WAS Analysis which preserves the subtest presentation order of the CSA. The WAS-AW has been hypothesised to produce lower ratios than the CSA because of the conflicting influence of reflective-impulsive style, see Chapter four, and therefore would not be expected to demonstrate concurrent validity with the CSA.

Typically, to establish concurrent validity, correlations of  $r = 0.8$  or above would be required (Kline, 2000), however, given the poor temporal reliability of the CSA correlations of  $r = 0.8$  or would not be expected. Chapter five demonstrated that the wholist-analytic dimension has poor test-retest reliability with correlations between 0.30 and 0.34 (Peterson et al., 2003a; Parkinson et al., 2004; Rezaei and Katz, 2004; Cook, 2008); temporal reliability increased to 0.53 (Peterson et al., 2003a) and 0.55 (Rezaei and Katz, 2004) when test length was doubled and speed was emphasised. Therefore, in the present study, a correlation between the WAS analysis and the wholist-analytic dimension of the CSA between  $r = 0.30$  and  $r = 0.55$  will be required in order to establish concurrent validity.

### **6.3.1 Participants and Measurements**

Twelve undergraduates (two male, ten female) with a mean age of 23.17 years completed Riding's CSA (1991) and the WAS-WA version of the WAS analysis to assess concurrent validity.

### 6.3.2 Procedure

All Participants were tested individually on the CSA and the WAS-WA in a quiet room in a relaxed environment. Respondents sat the tests alone in a small room with the door shut to avoid audience effects (Grant and Dajee, 2003). Completion of the CSA and the WAS analysis was counterbalanced such that half of the participants completed the CSA first followed by the WAS analysis and the other half completed the WAS analysis followed by the CSA.

### 6.4 Results

The overall speed of processing the eighty-item WAS-WA was 14.99 minutes compared to 6.85 minutes for the forty-item wholist-analytic dimension of the CSA (CSA-WA). The increased completion times and the increased spread of scores appropriately reflect the increased number of items in the WAS-WA see Table 6.1.

**Table 6.1: Mean and spread of completion times for WAS-WA and CSA (in minutes)**

Measurement	Mean	Standard Deviation	Minimum	Maximum
CSA-WA	6.85	1.42	4.76	9.23
WAS-WA	14.99	3.98	10.27	21.04

There was no significant difference between the accuracy of the WAS-WA and the CSA-WA ( $t = .707$ ,  $p = .519$ ), see Table 6.2; this suggests that the increased level of

complexity, which has been introduced through the inclusion of five-part geometric figures in the WAS analysis, has not made the test significantly more difficult.

**Table 6.2: Mean and spread of % accuracy for WAS-WA and CSA**

Measurement	Mean	Standard Deviation	Minimum	Maximum
CSA-WA	92.6	4.27	85	100
WAS-WA	90.6	4.56	84	95

There was no significant difference between the ratios produced in the CSA-WA and the WAS-WA ( $t = -.665$ ,  $p = .542$ ) see Table 6.3. The standard deviation and spread of scores were greater in the WAS-WA; this increased discriminatory power is likely to be an artefact of the increased number of test items.

**Table 6.3: Mean and spread of wholist-analytic ratio for WAS-WA and CSA**

Measurement	Mean	Standard Deviation	Minimum	Maximum
CSA-WA	1.08	0.21	0.83	1.59
WAS-WA	1.19	0.42	0.81	1.67

A bivariate Pearson correlation revealed coefficients of  $r = .45$  between the wholist-analytic style ratio measured by the CSA and the wholist-analytic style ratio measured by the WAS analysis.

### 6.4.1 Discussion

The response latencies produced by the WAS analysis are comparable to those on the wholist-analytic dimension of the CSA; this was demonstrated by the total completion times which are approximately double that of the CSA-WA. This is consistent with the fact that the WAS analysis has double the number of items in each subtest than the CSA wholist-analytic dimension, therefore the total completion times would be expected to be proportionately increased.

There was no significant difference in the accuracy or the ratios produced by the WAS-WA version of the WAS analysis and the wholist-analytic dimension of the CSA. This suggests that the increased complexity associated with the inclusion of five-part figures has not had a detrimental effect on the accuracy of respondents.

The WAS-WA demonstrated satisfactory concurrent validity of  $r = 0.45$ ; which is within the range of  $r = 0.30$  to  $r = 0.55$  typically found for wholist-analytic dimension test-retest reliability figures (Peterson et al., 2003; Parkinson et al., 2004; Rezaei and Katz, 2004; Cook, 2008). Given the lack of temporal reliability of the wholist-analytic dimension it would be unrealistic to expect concurrent validity to be achieved above the level of  $r = 0.55$ .

The consistency suggests that despite the revisions to the number of test items and the complexity of the figures, when the subtest order is preserved, the basis of the wholist-analytic ratio remains the same and the theoretical underpinnings of the measure have not been fundamentally altered. Therefore, findings relating to performance on the WAS-WA version of the WAS analysis can be generalised to the performance of the wholist-analytic dimension of the CSA.

## **6.5 Discriminatory power and internal consistency of the WAS Analysis and validation of the new part-whole ratio construct**

A second study was performed to further test the psychometric properties of the WAS analysis; in this study the discriminatory power of the WAS analysis was explored; the inter-item reliability and split half reliability was examined to test the internal consistency of the WAS analysis; and the construct validity of the new part-whole ratio was assessed.

### **6.5.1 Discriminatory power of the WAS analysis**

For any test to be valid it should have discriminatory power, defined as the “ability of a test to produce a spread of scores” (Kline, 2000, p. 30). In the context of the wholist-analytic dimension it is also important that both of the subtests have discriminatory power to ensure that the ability of the wholist-analytic dimension to discriminate between whole processors and part processors does not rest entirely on individual differences in performance on the matching figure test or the embedded figures test.

The wholist-analytic ratio should be a result of individual differences on both subtests to ensure that it is a bipolar measure of style as opposed to a unipolar measure of ability; indeed this is one of the main strengths of the measure according to Riding (Riding and Cheema, 1991; Riding, 1991). As a bipolar measure the wholist-analytic ratio would discriminate between relative abilities to part and whole process; but as a unipolar measure it would either discriminate between good and bad part processors or good and bad whole processors depending on which subtest is at the route of the individual differences in the wholist-analytic ratio.

The theory of diminished refraction proposed in Chapter four predicts that the early test items will have more power to discriminate between reflective and impulsive individuals and may therefore have a detrimental affect of the validity of the wholist-analytic measure. In this study, the median response latencies in each test quarter will be assessed for their power to discriminate between wholists and analytics.

### **6.5.2 Internal consistency of the WAS analysis**

Inter-item and split half reliability figures are not available for the CSA so direct comparisons cannot be made, however, split half reliability figures have been reported for replica and parallel forms of the CSA and an extended version of the CSA which combines replica and parallel forms, split half reliability for the replica and parallel form of the CSA has been reported as  $r = 0.62$  and  $0.56$ , respectively, and split half reliability of the extended version has been reported as  $r = 0.69$  (Peterson et al. 2003). The split half reliability of the WAS analysis will be assessed against the standard set by Peterson et al.'s extended CSA because both are eighty item tests and longer tests are likely to produce increased variation and therefore higher correlations (Kline, 2000).

### **6.5.3 Construct validity of the part-whole ratio**

The concept of the part-whole ratio is that individuals using a part processing strategy will take proportionately longer to process five-part complex figures than three part complex figures because each additional part in the complex figure will take extra processing time. Conversely, individuals using a whole processing strategy will not take proportionally longer to complete a five-part to a three-part figure because each complex figure is being processed as a gestalt. Since the matching figures task can be approached using a part or a whole processing strategy

then the part-whole ratio, which is based on the speed of processing three-part matching figure tasks to five-part matching figure tasks, should discriminate between those using a part processing approach and those using a whole processing approach.

The construct validity of the part-whole ratio can be tested by two hypotheses: 1) Analytics should have significantly lower part-whole ratios than wholists, indicating that they are using part processing for the matching figure tasks whereas wholists are using whole processing. 2) There should be no significant difference between analytics and wholists on the three to five-part ratio computed from the embedded figure tasks; this is because both style groups should be employing part processing of the embedded figure tasks regardless of their style because the embedded figures task by its nature requires a part processing strategy.

#### **6.5.4 Participants and Measurements**

Forty-seven participants (eighteen male, twenty-nine female) with a mean age of 22.45 years (SD 5.34 years) completed the WAS-WA to assess the internal consistency of the WAS Analysis and the construct validity of the part-whole ratio. All participants completed the WAS-WA whilst alone in a quiet room and in a relaxed environment.

## 6.6 Results

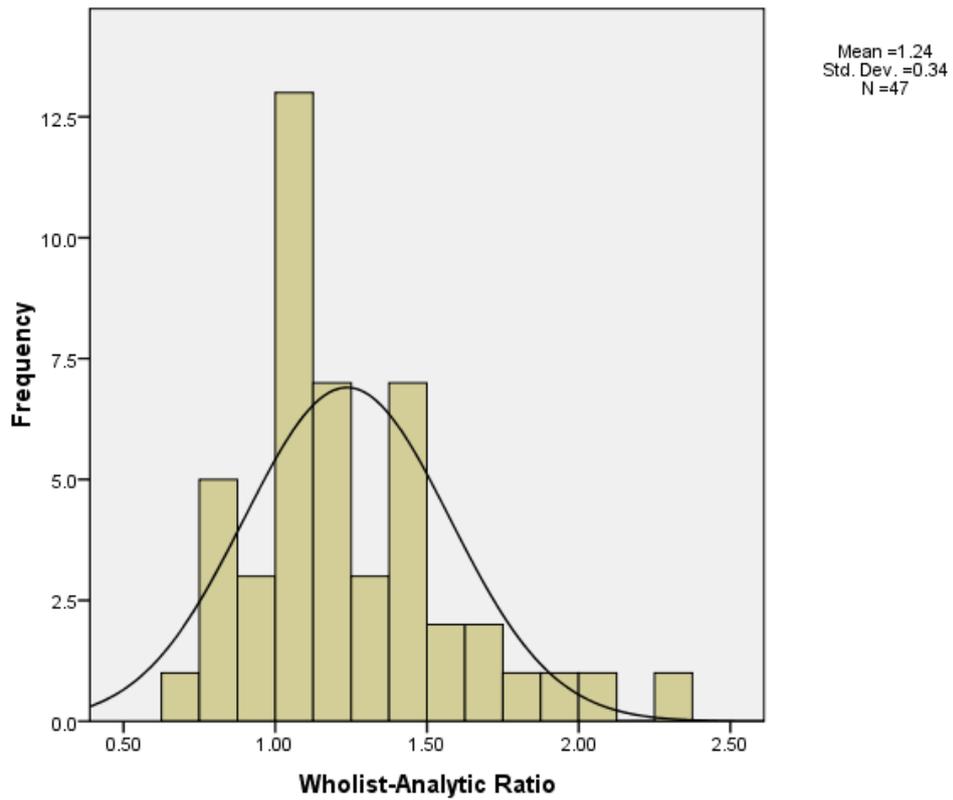
### 6.6.1 Discriminatory Power of the wholist-analytic dimension

Participant ratios on the WAS analysis were categorised into three equal groups and labelled wholist, intermediate and analytic. The ratio classifications were compared with the guidelines provided in the CSA manual (Riding, 1991; 1998). Table 6.4 shows that there was a high degree of consistency between the ratio cut off points produced by the WAS-WA, and the CSA guidelines.

**Table 6.4: Comparison of style ratio cut off points of the WAS-WA and the CSA-WA**

Classification labels	WAS Analysis		CSA Guidelines
	N	Ratio	Ratio
<b>Wholist</b>	15	$\leq 1.03$	$\leq 1.02$
<b>Intermediate</b>	17	$> 1.03 < 1.38$	$> 1.02 < 1.36$
<b>Analytic</b>	16	$\geq 1.38$	$\geq 1.36$

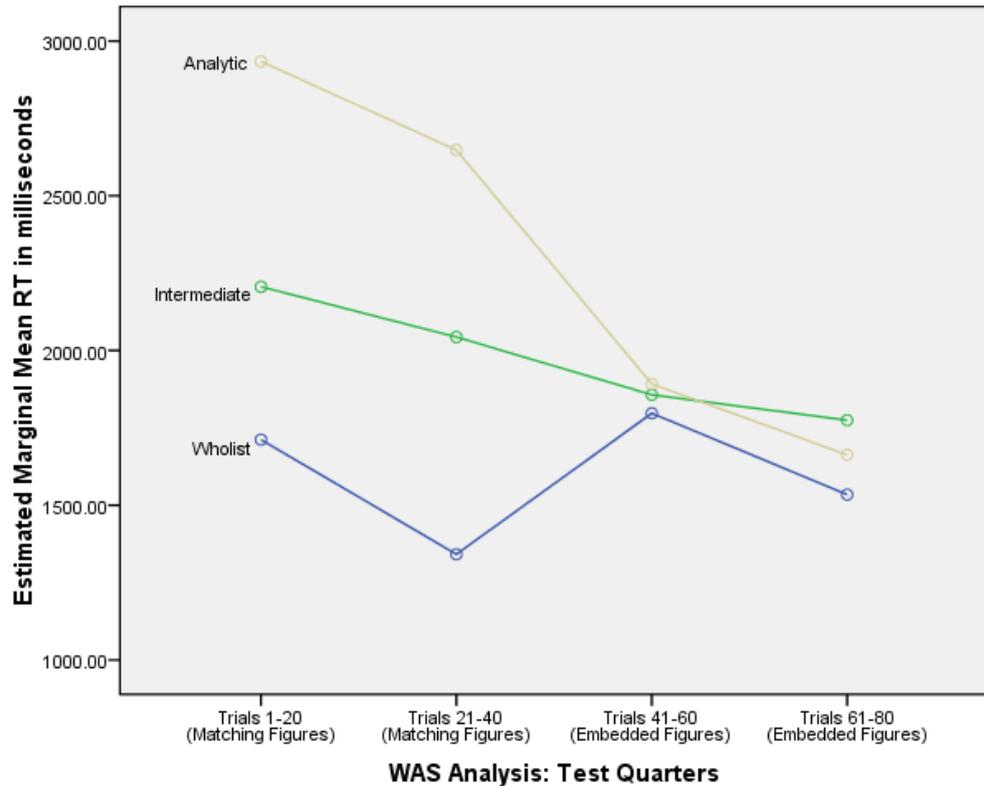
Respondents produced a satisfactory spread of wholist-analytic ratios with a mean of 1.24 and a standard deviation of 0.34. A Kolmogorov-Smirnov test showed that the ratios were approximately normally distributed ( $Z=0.85$ ,  $p= .460$ ) see Figure 6.11.



**Figure 6.11: Histogram showing the distribution of the Wholist-Analytic Ratio**

In order to examine the discriminatory power of both subtests and to explore the theory of diminished reflection proposed in Chapter four, the discriminatory power of the wholist-analytic dimension was assessed across each test quarter. Since the test has eighty items, the score for each quarter represents the mean response latencies of wholists, analytics and intermediates to each block of twenty trials. In this study, the WAS-WA was used, which preserves the subtest order of the CSA, therefore, the first two test quarters were matching figure trials and the third and fourth quarters were embedded figure trials.

It is clear from Figure 6.12 that group differences in the mean latencies in the first two test quarters discriminated more effectively between the wholist, analytic and intermediate style categories than mean latencies in the third and fourth quarters.



**Figure 6.12: Style group mean latencies for WAS Analysis test quarters.**

A one-way ANOVA revealed a significant effect of style on the mean latencies for the matching figure items in the first and second quarters of the WAS Analysis ( $F_{2,44} = 4.062, p = .024$ ;  $F_{2,44} = 8.112, p = .001$ ). Bonferroni post hoc tests confirmed that the analytics took significantly longer than wholists to process the first and second group of twenty matching figure items with means of 2363 ms for analytics and 1933 ms for wholists in the first quarter and means of 2068 ms and 1436 ms in the second quarter. Intermediates did not significantly differ from analytics or wholists in either quarter.

There was, however, no significant effect of style on the embedded figure items in the third and fourth quarters of the test ( $F_{2,44} = .041$ ,  $p = .960$  and  $F_{2,44} = .606$ ,  $p = .550$ ). The style groups produced very similar mean latencies for the third quarter (analytics: 1892 ms, intermediates: 1857 ms and wholists: 1927 ms) and similar means for the last quarter (analytics: 1663 ms, intermediates: 1775 ms and wholists: 1535 ms).

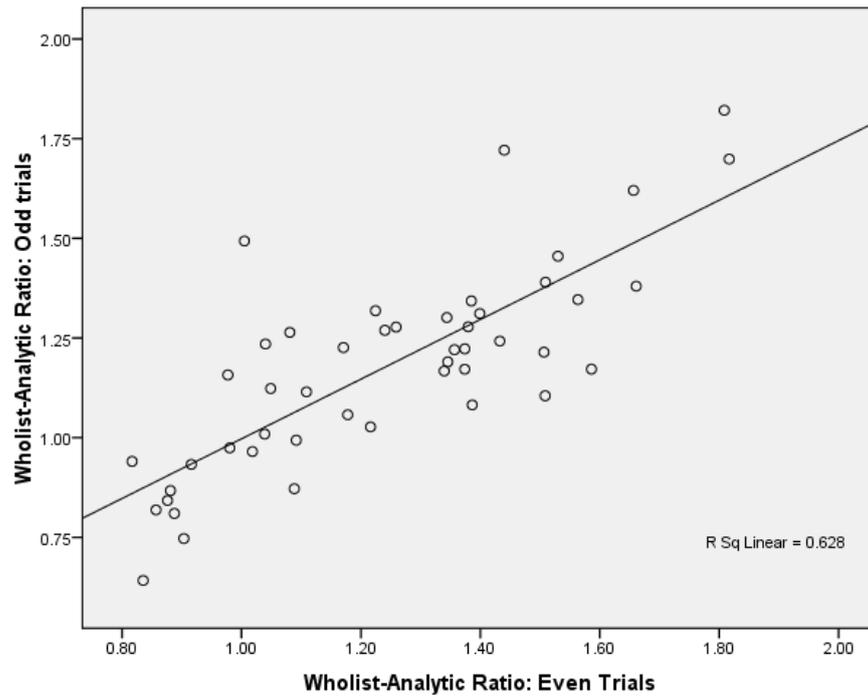
### **6.6.2 Inter-item consistency**

An item analysis based on speed of processing each of the eighty matching figure and embedded figure tasks produced a Cronbach Alpha of .98; alphas for the forty matching figure items and for the forty embedded figure items were .96

A further item analysis of the forty matching figures and embedded figures with complex figure stimuli constructed from three simple shapes produced an alpha of .96 and the forty items with five-part complex figures was .95. Alphas for three-part matching figures, five-part matching figures, three-part embedded figures and five-part embedded figures were .94, .93, .92 and .91, respectively.

### **6.6.3 Split half reliability**

Two wholist-analytic ratios were computed; one from the odd numbered matching figure and embedded figure items and the other from the even items. The WAS analysis demonstrated a stable split half reliability of  $r = 0.68$ , see Figure 6.13.



**Figure 6.13: Scatter gram of split half wholist-analytic ratios**

Split half reliabilities were reduced when they were based on five-part figures only ( $r = 0.43$ ) and three-part figures only ( $r = 0.57$ ) and reduced further when ratios were computed for five part figures by three part figures ( $r = 0.35$  to  $0.55$ ).

Split half reliabilities based on reaction time produced coefficients 0.95 for wholist items and 0.93 for analytic items. The three and five part matching figure items produced split half reliabilities of 0.92 and 0.91, respectively, and the lowest reliabilities were produced by the three and five part embedded figure items, 0.85 and 0.88, respectively. See Table 6.5 for a summary of all split half reliabilities for ratios and reaction times.

**Table 6.5: Summary of all split half reliabilities for ratios and reaction times**

Split Half Reliabilities	RT stability	Ratio stability
Wholist-Analytic Ratio		0.68
Matching Figure Items	0.95	
Embedded Figure Items	0.93	
5- Part by 3- Part Wholist-Analytic Ratios		0.35; 0.40; 0.40; 0.55
Three Part Matching Figure Items	0.92	
Three Part Embedded Figure Items	0.85	
Three Part Wholist-Analytic Ratio		0.57
Five Part Matching Figure Items	0.91	
Five Part Embedded Figure Items	0.88	
Five Part Wholist-Analytic Ratio		0.43

#### 6.6.4 Construct validity of the part-whole ratio

The analytic group produced a lower mean part-whole ratio than the wholists as expected (.755 to .808) but a t-test revealed that the difference was not significant ( $t = 1.360$ ,  $p = .095$ ,  $d = 0.53$ ,  $N^1 = 15$ ,  $N^2 = 12$ ). The results approached significance with a p value within the significance 10% level.

However, a post hoc test of power performed by G\*power demonstrated that for this small sample size with a moderate effect size of 0.53 there was insufficient power in the t-test ( $1-\beta$  err probability = 38%) so there is the chance of a type 1 error. To ensure adequate power 45 participants are needed in each group to achieve the minimum acceptable power level of 80%. The construct validity of the part-whole ratio will be re-assessed in Chapter nine using the recommended sample size.

A t-test revealed that there was no significant difference between the EFT ratios with means of .904 for wholists and .924 for analytics ( $t = -.453$ ,  $p = .327$ ). This time there is no risk of a type 1 error; the effect size is very small ( $d = 0.17$ ) indicating little or no effect. Power is very low ( $1-\beta$  err probability = 11%) but to achieve a minimum acceptable power in the t-test of 80% with such a small effect size a sample of 818 participants would be required.

## **6.7 Discussion**

### **6.7.1 Discriminatory power of the WAS analysis**

The WAS analysis had a satisfactory spread of ratio scores and a Kolmogorov-Smirnov test confirmed that ratios were approximately normally distributed; however, the mean latencies in the first and second test quarters had the power to discriminate between wholists and analytics but the third and fourth quarters did not. This can be interpreted in three ways:

1) The theory of diminished reflection, proposed in Chapter four, can account for the discriminatory power of the first two test quarters. If this is the case then the wholist-analytic ratio does not measure differences in part and whole processing but instead discriminates between reflective-impulsive styles by measuring relative tendencies to approach early test items slowly with a degree of caution or to respond quickly with little or no reflection.

2) In this study the first two quarters combined to form the matching figures subtest, therefore, it could be argued that the matching figures test had discriminatory power and the embedded figures test did not. This would suggest that the wholist-analytic

ratio is a unipolar measure of individual differences in the ability to complete whole processing tasks.

3) The asymmetry in the nature of the processing being measured by the wholist-analytic ratio, which was proposed in Chapter four, suggests that all participants use part processing for the embedded figures tasks but that whole processors choose to whole process the matching figure tasks and part processors choose a part processing strategy. When combined with the fact that only the matching figure tasks have discriminatory power this suggests that the wholist-analytic ratio is discriminating between the efficacy of a part processing strategy compared to a whole processing strategy when completing a task designed to favour whole processing.

The three explanations above are not mutually exclusive and they all raise questions over the validity of the wholist-analytic ratio. These questions will be addressed in Chapter nine, a comparison of the discriminative power of the WAS-WA and the WAS-AW will reveal whether the power relates to a reflective-impulsive style difference or a difference in part-whole processing.

### **6.7.2 Concurrent validity of the WAS analysis**

The WAS Analysis took approximately twice as long to complete than the wholist-analytic dimension of the CSA which reflects the fact that it has double the number of items; eighty items compared to forty. There was no significant difference in the accuracy of the responses, which suggests that the increased complexity of the five-part figures has not led to a significant increase in errors. There was no significant difference in the ratios produced by the WAS analysis and the CSA and when split into three equal groups the ratio thresholds for wholist, intermediate and analytic styles on the WAS analysis were consistent with the guidelines published in the CSA manual (Riding, 1991; 1998).

Respondents wholist-analytic style as measured by the WAS analysis and the CSA demonstrated a moderate correlation of  $r = 0.44$ . This demonstrates good concurrent validity in the context of the moderate test-retest coefficients reported in the literature for the CSA ( $r = 0.31$  to  $0.55$ ).

### **6.7.3 Internal consistency of the Wholist-Analytic Ratio**

The wholist-analytic ratio was internally consistent; producing a Pearson split half correlation of  $0.68$ . The split half reliability of three part and five part figures were lower at  $r = 0.57$  and  $0.43$ , respectively. Stability of the WAS Analysis can not be compared to the CSA because it is not open to individual item analysis but the correlations are comparable to Petersons extended eighty item CSA ( $r = 0.69$ ), the forty item replica form CSA ( $r = 0.62$ ) and the forty item parallel form CSA ( $r = 0.56$ ) (Peterson et al, 2003).

The WAS analysis demonstrated excellent inter item reliability; Cronbach alphas ranged from  $0.91$  to  $0.98$  when item latencies were correlated.

### **6.7.4 Construct Validity of the Part-Whole Ratio**

Construct validity could not be satisfactorily demonstrated for the part-whole ratio because of an inadequate sample size leading to insufficient statistical power. However, the ratio did show promise with a moderate effect size suggesting that the analytics were part processing the matching figures tasks and the wholists were whole processing. Further, validation will be conducted in Chapter nine with a sufficiently large sample of at least ninety participants.

The initial findings relating to the part-whole ratio imply that there is an asymmetry in the nature of the processing being employed by the analytic and wholist respondents; suggesting that the analytics are part processing the matching figure items and the embedded figure items whereas the wholists are whole processing the matching figure items and part processing the embedded figure items.

### **6.7.5 Conclusion**

The discriminative power of the WAS analysis appears limited to the first two quarters of the test which in the WAS-WA version represents the matching figures subtest. The problems with discriminatory power are consistent with the theories proposed in Chapter four, which suggest that the wholist-analytic ratio is sensitive to reflective-impulsive style and has an asymmetry in the nature of processing being measured. In this respect, the CSA is hypothesised to share the same problems in discriminatory power. The construct validity of the part-whole ratio was partially demonstrated but this will be readdressed more effectively in Chapter nine. The WAS analysis demonstrated concurrent validity and internal stability with good split half reliability and excellent inter item stability and therefore has been shown to be valid for its purpose, that is to expose the limitations of the CSA outlined in Chapter four.

**Chapter 7:**  
**Construction and Validation**  
**of the**  
**Convergent-Divergent Thinking Style Test**

## **Chapter 7: Construction and validation of the Convergent-Divergent Thinking Style Test**

### **7.1 Chapter Introduction**

The terms convergent and divergent thinking were proposed by Guilford in the early 1950s (Guilford, 1956). Convergent thinking is required to solve structured problems, which have one correct solution. Divergent thinking is required when dealing with open-ended problems, in which the goal is to generate a number of novel solutions. Liam Hudson (1967) adopted these terms and was the first to use them in a way, which is consistent with the current conception of cognitive style. Hudson described two types of clever schoolboy, the boy who excelled at IQ tests but was relatively weak at open-ended tests and the boy who excelled at open-ended tests but was weak at IQ tests; he labelled these types of boy as convergers and divergers, respectively.

#### **7.1.1 Conception of convergent-divergent style**

Over the course of five years Hudson tested one hundred to two hundred young boys every year from eight different schools, five public schools and two grammar schools. His samples were unusually bright and were taken from schools within a one hundred mile radius of London (Hudson, 1967).

His research began to yield results suggesting that arts specialists had biases towards verbal intelligence and the scientists had biases towards numerical or diagrammatic intelligence. But more interesting than this, from a cognitive styles perspective, is a discrepancy that captured Hudson's attention; the IQ tests failed time and time again to identify really bright schoolboys who had demonstrated their talent in academic

success and/or extracurricular interests and achievements. Hudson conceded that an individual with high IQ has greater ‘Intelligence’ than an individual with a low IQ but in a sample of already high IQ individuals, IQ tests failed to adequately predict present or future success, he wrote:

“It is amply proved that someone with an IQ of 170 is more likely to think well than someone whose IQ is 70. And this holds true where the comparison is much closer – between IQs of say 100 and 130. But the relation seems to break down when one is making comparisons between two people both of whom have IQs which are relatively high” (Hudson, 1967, p.43)

Hudson suspected that what the IQ tests were failing to measure was the originality of the thinking demonstrated by some of the brightest boys. Whilst he came to this hypothesis independently, the next stage of his research was heavily based on the work of Getzels and Jackson (1962) and his research was based on their tests and many of their specific techniques.

Getzels and Jackson (1962) identified a ‘High IQ’ group’ who performed to a high standard on IQ tests but performed less well on what they termed ‘tests of creativity’; and a ‘High Creative’ group who did very well on creativity tests but relatively less well on IQ measures. Hudson replaced these terms; labelling the high IQs as convergers and the high creatives as divergers because he objected to the misleading use of the term creativity; for the same reason he referred to the tests of creativity as open-ended tests.

Getzels and Jackson used an equivalently large sample that was also unusually bright (mean IQ of 132, standard deviation 15) and drawn from an American private school. The main difference between the work of Getzels and Jackson and Hudson’s own research is that they used a mix of boys and girls (292 and 241, respectively) whereas Hudson used predominantly all boys; and Hudson’s schoolboys were a self selected

sample of arts and science students because in English public schools at that time boys were required to specialise early.

Getzels and Jackson compared the scholastic achievement of the High IQ and High creative groups based on their mean numerical and verbal school achievement test scores. They found that the High IQ group had significantly higher mean achievement test scores than the population mean but also that the High creative group did significantly better than the population on their verbal and numerical achievement tests. By definition, the 'high creatives' had lower IQ scores than the high IQ group and lower mean IQ than the population average, but despite the 23 point difference in mean IQ, both groups performed significantly better than the population on standardised achievement tests.

Similarly, Hudson compared the IQ scores of 375 boys tested between the ages of 15 and 17 years with their later academic accomplishment at university. He categorised their achievement into 4 levels: those who had become scholars and exhibitors at Oxford and Cambridge, those who were commoners at Oxford and Cambridge, those who attended other universities and those who did not go to university. He also banded the IQ scores collected in the sixth form into 5 groups (A, B, C, D and E) with 'A' representing the highest scoring 20% through to 'E' representing the lowest 20%. Hudson found that there was no significant difference in the IQ classifications between the future scholars and their less successful university counterparts, the only group who differed from the others were those who did not attend university; Hudson writes:

“If scholarships and exhibitions had been awarded to members of my present sample on the basis of IQ alone, 15 or 16 would have gone to boys who actually won scholarships and exhibitions, 14 or 15 would have been given to Oxford and Cambridge commoners, 21 or 22 to boys who went to other Universities, and 10 or 11 to boys who went to no University at all. In other words we would have given

129

scholarships to only a quarter of those who received them, in fact: only a handful more than one would have expected by chance.”(Hudson, 1967, p.178)

These findings suggest that whilst IQ scores may predict the achievement of a subset of the population they fail to predict the past, present or future academic success of those individuals who show relatively superior cognitive functioning on open-ended tests.

### **7.1.2 Measuring convergent-divergent style**

Hudson (1967) and Getzels and Jackson (1962) classified their convergent or High IQ groups and their divergent or high creativity groups in a similar fashion. Hudson uses the AH5 (Alice Heim 5 Test, cited in Hudson, 1967) to measure IQ and two open ended tests; the object uses and meaning of words test. Getzel and Jackson used existing IQ records which provided scores based on the Binet, Henmon-Nelson and a handful of WISC scores, all were standardised to Binet IQs. These were compared with combined creativity scores from five tests; uses for things, word association, hidden shapes, fables and make-up problems.

Hudson used the AH5 as a measure of IQ and compared this with the performance on two open ended tests; the object uses test and the meaning of words test. He classified his boys as convergers and divergers based on their relative performance on the IQ test and the open ended tests.

Hudson replicated Getzels and Jackson’s ‘uses for things’ test changing it’s name to the ‘uses of objects’ test; it is essentially the same test with two of the items changed. The test required respondents to produce as many uses as they can for 5 everyday objects. Getzels and Jackson compiled their test based on two similar tasks used by Guildford (1956) in the factor analytic studies of the structure of intellect. The test is

administered without a time limit but Hudson recommended 15 minutes as ample completion time.

Hudson's 'meaning for words' test was also replicated from Getzels and Jackson's word association test, Hudson changed the name because he felt it was misleading. The test requires respondents to produce as many definitions for a list of ten words as they can, for instance 'sack' may refer to a bag that contains potatoes or coal, or it could refer to the act of relieving someone of their employment.

There is no standardised test to measure convergent-divergent thinking style but the convention is to use a combination of open-ended test items, which require the generation of multiple responses, with closed test items, which require the convergence on one correct answer. Recent examples of convergent-divergent style measurements used in the literature have been based on Getzel and Jackson's (1962) and Hudson's (1967) original work (e.g. Bahar and Hansell, 1999; Runco, 2007; Nielson, Pickett and Simonton, 2008). Verbal convergent tasks such as those used in intelligence tests are commonly used to measure convergent thinking, an example of a commonly used convergent task is 'remote associates' in which respondents are presented with three target words and the task is to identify one word which is related to the other three. The most commonly used measures of divergent thinking are the object uses test, in which the task is to generate uses for given objects, and attribute tasks, in which the task is to generate words or objects which share a given attribute (Nielson et al., 2008). Table 7.1 provides an example for each of the types of task.

**Table 7.1: Convergent and Divergent task examples**

<b>Task type</b>	<b>Example Item</b>
<b>Remote associates</b>	What word are all three of these words related to? - Pool, Tennis, Turn
<b>Object uses</b>	List as many uses for a paperclip as you can think of
<b>Attribute tasks</b>	List as many things words beginning with the letter T

### **7.1.3 Construction of a convergent-divergent thinking test**

Since the object uses test and the attribute test have been the most consistently employed measures of divergent thinking they have been selected again for use in the current study. The consequence test has also been chosen as a third measure of divergent thinking (Wilson, Guilford and Christensen, 1953; Torrance, 1974). The consequence test poses the question ‘What would happen if the Earth lost it’s gravity’ and respondents are required to generate the possible consequences of such an event; Hudson used similar opened tests to assess the qualitative differences in convergers and divergers responses. He avoided using such tests in the convergent-divergent style calculation because of the problems inherent in quantifying responses. Therefore, in the current study only the ideational fluency of alternative consequences will be measured not the quality.

The attribution task selected for this study involved generating words that begin with a particular letter. This verbal task is similar in nature to Hudson’s (1967) meaning

of words task but its increased simplicity makes it less likely to measure ability and experience.

The divergent thinking test is, therefore, in three sections; the first section consisted of two out of five items from the 'object uses test', the full five items have not been included to avoid the divergent test becoming overly long; the second section was the consequence task; and, the third section presented the word generation task.

A selection of verbal intelligence test items (Daughtrey, 1993) have been used to assess convergent thinking; the relative performance of individuals on the convergent and divergent thinking tests will determine their convergent-divergent cognitive style. However, there is no standard method of assessing relative performance when employing open-ended tests.

#### **7.1.4 Assessing relative performance on Convergent and Divergent tasks**

Convergent-divergent style is assessed by the relative performance of individuals on open and closed tests. It is therefore necessary that scores on both tests be standardised to enable direct comparisons; this is more difficult to achieve with an open-ended test because there is no theoretical maximum score.

Hudson (1967) standardised his respondents scores on the IQ test and their fluency scores on the open ended tests by allocating points in the following proportions 1:2:4:2:1. The first 10% are awarded -2, the next 20% get -1, and the middle 40% get 0, the next 10% get 1, and the final 20% get 2. Points awarded for IQ proportions are reversed and the mean of the two open ended tests is contrasted with the IQ score yielding differential scores ranging from -4 which is extremely convergent to +4 which is extremely divergent.

One of the limitations with this method is that it restricts the variability of scores, reducing discriminatory power. Al-Naeme (1991) used an alternative method; he placed an upper limit on the divergent fluency responses, which was equivalent to the maximum score on the convergent test.

Al-Naeme (1991) devised a series of six subtests to assess convergent-divergent style, based on Getzels and Jacksons (1962) and Hudsons (1967) original works. The scoring of the convergent-divergent tests imposed a restriction on the number of allowable responses to divergent items; for example students were asked to draw up to five different pictures to relate to the idea of a given word. However, Hudson (1967) has demonstrated that when the number of responses is specified it becomes a measure of ability rather than typical response.

Hudson (1967) demonstrated the distinction between ability and divergent style by manipulating the instructions given to participants taking part in the object uses test. When instructions required respondents to produce at least 25 uses, 65% were able to do so. However, using the standard instructions, which require participants to produce as many uses as possible, only 7% generated a minimum of 25 responses. This suggests that the object uses test is a measure of typical performance or style rather than ability.

Therefore, when asked to produce as many responses as they can, convergent individuals reveal a tendency to offer fewer responses to open ended tests but when instructed to provide a specific number of responses they are as capable as the divergent individuals in producing sufficient responses.

A more practical and valid alternative would be to standardise both sets of scores by converting them to  $z$  scores. Therefore, in the present study  $z$  scores on the convergent tests were contrasted with  $z$  scores based on the fluency of responses to open ended tests. The standardised convergent scores was deducted from the

standardised divergent scores producing positive scores which indicate relatively better performance on the divergent task and negative scores which indicate relatively better performance on the convergent task.

### **7.1.5 Categorising Convergents and Divergers**

Hudson (1967) labelled the lowest 30% of participants ‘convergents’, the mid 40% ‘all rounders’ and the top 30% ‘divergers’. Whilst this implies a typology, Hudson clearly saw the convergent-divergent dimension as a continuum since at times he distinguished between extreme convergers (lowest scoring 10%) and mild convergers (remaining 20%) and between extreme divergers (top scoring 10%) and mild divergers (remaining 20%). He also employed correlation methods using the full spectrum of standardised scores -4 to +4.

The same category proportions have therefore been applied to the standardised z score comparisons used here, with the lowest 30%, mid 40% and highest 30% being labelled convergent, all rounder and divergent, respectively.

This chapter outlines the development and validation of the convergent-divergent style measure; three studies will be described which assessed the discriminatory power and construct validity of the new measure which resulted in a series of revisions to the convergent-divergent style test.

## **7.2 Discriminatory Power of the convergent-divergent style measure**

In order for the convergent-divergent measure to demonstrate satisfactory power to discriminate between convergent and divergent thinkers, each section of the test should produce an approximately normal distribution of scores. Moderate

correlations are also expected between the sections of the convergent thinking tests and divergent thinking tests to demonstrate internal consistency.

### **7.2.1 Design and Participants**

Seventy-eight psychology undergraduates took part; forty participants (thirteen male, twenty-five female, two not stated), with a mean age of 23.52 years (Standard deviation 1.6 years), completed the convergent thinking test ; and, thirty-eight participants (eight male, thirty female), with a mean age of 20.62 years (Standard deviation 0.74 years), completed the divergent thinking test.

### **7.2.2 Measurements: The convergent and divergent thinking tests**

The convergent thinking test has three section, the items are taken from Daughtrey's (1993) collection of verbal reasoning test papers. The first section requires connections to be made between words, based on category judgements, and contains seven items. The second section involves identifying and following patterns to complete a word pair, this section contains eight items. The third section involves breaking a code and using it to translate five words. The test instructions and examples of test items from each section are shown in Figure 7.1.

Daughtrey (1993) imposed a fifty-minute time limit for her one hundred-item test; therefore a ten-minute limit was applied to this twenty-item test. Each item was awarded two points producing possible scores ranging from zero to forty.

**Section 1:** There is a connection between the three words on the outside of the brackets and TWO of the words inside the brackets. Underline the two words. Here is an example:

QUEEN LADY MOTHER (king lord aunt prince princess)

**Section 2:** Write in the brackets the word needed to complete the third pair of words. This pair follows the same pattern as the first two pairs of words. Here is an example:

Heir her: baby bay: pain (pan)

**Section 3:** Here are five words:

PEAR TRAP RATE TEAR PART

Below these five words have been written in code but not necessarily in the same order. The same code has been used for all the words. Write in the brackets the word which stands for each of the code words:

@	*	/	?	( _____ )
/	?	*	@	( _____ )
!	?	*	@	( _____ )
/	@	*	!	( _____ )
!	*	@	/	( _____ )

**Figure 7.1: Examples of convergent thinking test items for each of the three sections**

The divergent test is also in three sections; section one consists of two of the items from Hudson's (1967) object uses test; section two consists of a consequence task which poses the question "What would be the results if everyone suddenly lost the sense of balance and were unable to stay in an upright position?"; and, section three is an attribute task in which words must be generated which begin with the letter 'T', see figure 7.2. Fluency is measured by awarding one point for every response generated and a ten-minute time limit is imposed on the test. There is no theoretical maximum score.

<p><b>Section 1:</b></p> <p>Below are two everyday objects. Think of as many different uses as you can for each:</p> <p>A barrel A paper clip</p> <p><b>Section 2:</b></p> <p>Consider the following question and list as many reactions as possible:</p> <p>"What would be the results if everyone suddenly lost the sense of balance and were unable to stay in an upright position?"</p> <p><b>Section 3:</b></p> <p>List as many words as you can think of beginning with the letter T.</p>
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**Figure 7.2: Divergent test items**

### 7.2.3 Results and Discussion

#### *Discriminatory power of the convergent thinking test*

The theoretical maximum scores for section one, two and three are fourteen, sixteen and ten, respectively. Measures of central tendency and dispersion were calculated to examine the distribution of scores across each test section (see Table 7.2).

**Table 7.2: Measures of dispersion and central tendency for participants' scores on convergent test sections.**

	<b>Section 1: Category Judgements</b>	<b>Section 2: Word pair patterns</b>	<b>Section 3: Word codes</b>
<b>Mean</b>	10.75	6.05	7.15
<b>Median</b>	13.00	6.00	10.00
<b>Standard deviation</b>	4.28	4.74	4.32
<b>Range</b>	13	16	10
<b>Kolmogorov-Smirnov Z</b>	1.676	.972	2.501
<b>Significance level</b>	.007	.302	.000

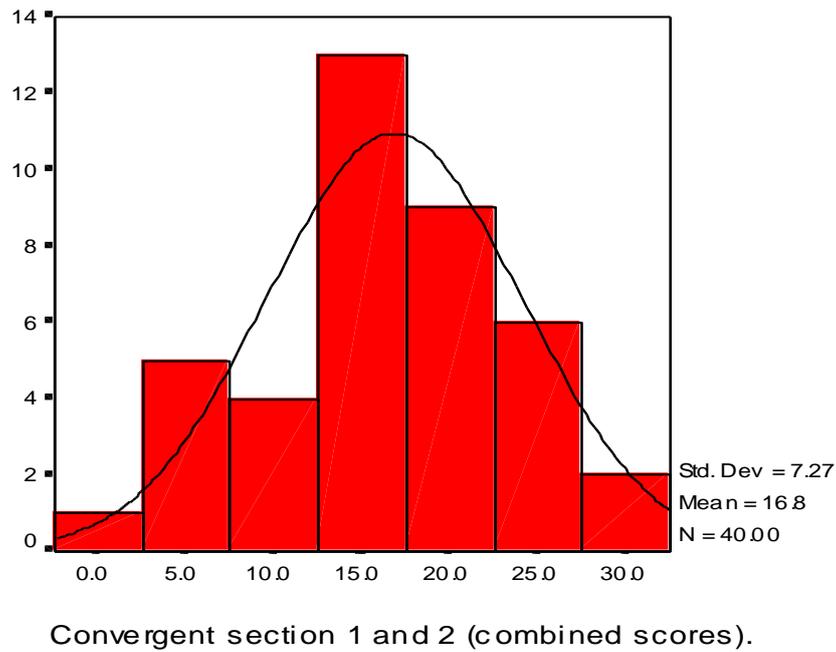
Section one scores fell significantly outside normal distribution ( $Z=1.676$ ,  $P=0.007$ ). Whilst a full range of scores was obtained, 42.5% of participants scored the theoretical maximum of fourteen. The median of thirteen is the most representative measure of central tendency and is almost double the theoretical mean of seven.

Section two scores were approximately normally distributed ( $Z = .972$ ,  $P = 0.302$ ). A full range of scores was obtained. The mean and median are most representative of the central tendency since 55% of participants scored 6 or below, which is below the theoretical mean of eight.

Section three scores fell significantly outside normal distribution ( $Z = 2.501$ ,  $P < .001$ ). Whilst the range indicates a full spread of scores, the reality is that 25% scored zero and 65% scored the theoretical maximum of ten. The remaining 10% represents just four people achieving a score other than the theoretical maximum or minimum.

Section two scores significantly correlated with section one scores ( $r = .30$ ,  $P = .030$ ). Section three scores did not significantly correlate with either section one scores ( $r = .188$ ,  $P = 0.123$ ) or section two scores ( $r = .303$ ,  $P = .290$ ). However, the lack of variance in scores on section three will have reduced the sensitivity to correlation measures.

The most satisfactory approximation to normal distribution is achieved when sections one and two are combined and section three scores are omitted ( $Z = .601$ ,  $P = 0.863$ ), see Figure 7.3.



**Figure 7.3: Histogram with normal distribution curve showing the frequency of participants combined scores on section 1 and 2**

### *Divergent Thinking Test*

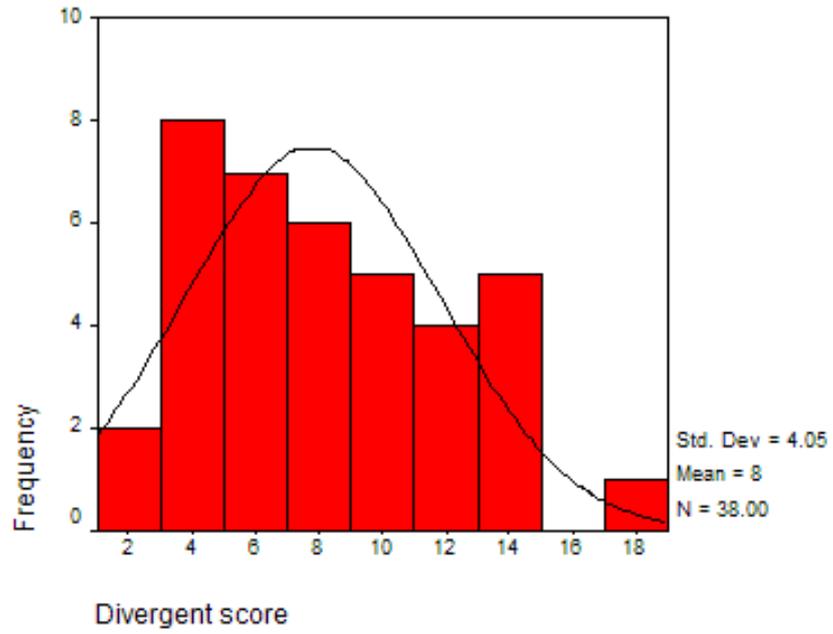
The divergent test was in three sections and each section was scored on the number of responses generated. Each response was awarded one point and there were no theoretical mean or maximum scores. A problem arose during the scoring of section two, the consequence test, due to the variability in the nature of participant responses. The responses generally represented a brief scenario rather than lists of discrete consequences and the responses were very limited in terms of the number of consequences generated. As a result, section two has not been included in the analysis and will be omitted from future versions of the divergent test. The

distribution of participant scores for the remaining sections have been analysed and summary statistics are shown in Table 7.3.

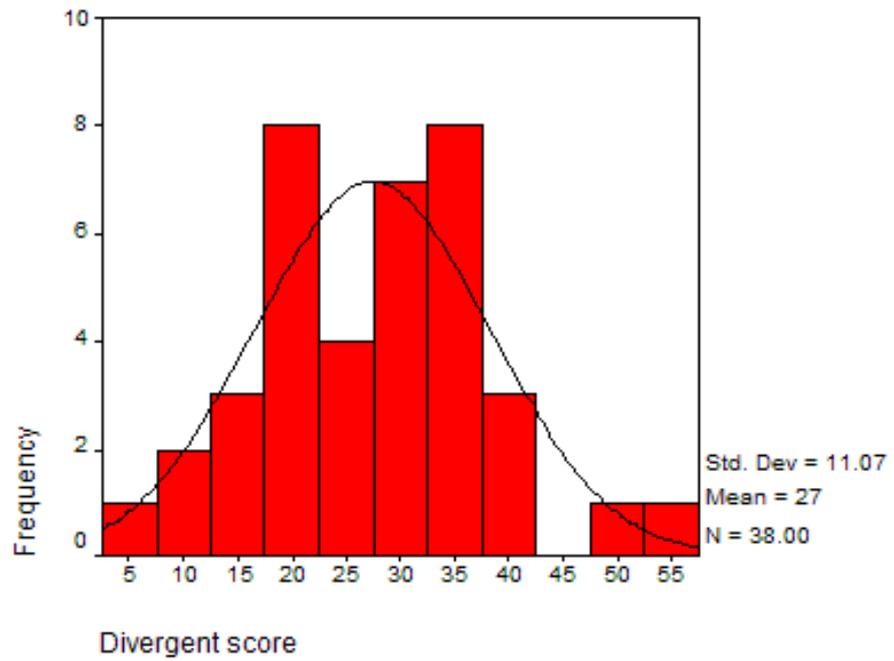
**Table 7.3: Measures of dispersion and central tendency for participants' divergent test scores**

	<b>Section 1: Object Uses Test</b>	<b>Section 3: Word generation task</b>	<b>Total</b>
<b>Mean</b>	7.79	27.39	35.18
<b>Median</b>	7.50	28.50	37.50
<b>Mode</b>	3.00	19.00	40.00
<b>Standard deviation</b>	4.05	11.07	13.02
<b>Range</b>	15	52	63
<b>Kolmogorov-Smirnov Z</b>	.728	.625	.711
<b>Significance level</b>	.664	.830	.693

Scores for section one and section three were approximately normally distributed ( $Z = .728$  and  $.625$ , respectively). Participants generated a greater number of responses to the word generation task than to the object uses task; means of 7.79 and 27.39, respectively, see Figures 7.4 and 7.5.



**Figure 7.4: Distribution of scores on section one – The Object Uses task**



**Figure 7.5: Distribution of scores on section three – The Word Generation task**

The scores were slightly skewed to the left for section one scores, indicating that participants found it harder to generate object uses than to generate word beginning with 'T'.

When sections one and two were combined, the total divergent scores were also approximately normally distributed ( $Z = .711$ ,  $P = .693$ ). Scores in section one correlated with scores in section two ( $r = .34$ ,  $p < 0.05$ ).

#### **7.2.4 Conclusion**

An analysis of the convergent test revealed that section one scores produced some ceiling effects but when combined with section two, produced scores that were approximately normally distributed. Both sections correlated with each other demonstrating internal consistency across tasks. Section three acted like a one item test and lacked discriminatory power, this is because in general participants either cracked the code and then correctly deciphered all of the words or they failed to crack the code and were therefore unable to decipher any of the words. Section three will be omitted from future versions of the convergent thinking test.

Section two of the divergent thinking test section two, the consequence test, was omitted from the analysis owing to problems with the classification of responses and the lack of variation in the number of responses generated. The divergent test therefore consisted of two sections, the object uses test and the word generation task, which were both approximately normally distributed and correlated with each other demonstrating internal consistency across tasks.

The next phase in the development and validation of a convergent-divergent style measure tested the discriminatory power of the revised convergent and divergent

tests, outlined above, in relation to each other and also addressed the notion of construct validity.

### **7.3 Discriminatory power and construct validity of the convergent-divergent style measure**

In this study, all participants completed the revised convergent test and the revised divergent test; and, their relative performance was assessed in terms of the power of the divergent test to discriminate high or low convergent thinking and the power of the convergent test to discriminate high or low divergent thinking.

The construct validity of the convergent and divergent tests was also assessed in two ways: performance of the convergent-divergent thinking test was compared to scores on the Cognitive Styles Index (CSI, Allinson and Hayes, 1996); and the power of the tests to discriminate between those who produce original responses and those who produce common responses on the divergent tests was examined

As a member of the wholist-analytic style family (Riding and Cheema, 1991), convergent-divergent style should be associated with scores on the CSI. The CSI is a self-report measure that assesses the super-ordinate style analytic-intuitive. The CSI was chosen because it represents a similar super-ordinate conception as Riding's wholist-analytic dimension but it has been judged as one of the most reliable and valid global-analytic style measures (Coffield et al., 2004).

Participant position on the convergent-divergent style dimension was expected to discriminate between analytic and intuitive scores on the CSI. Convergents are expected to be more analytic and divergers to be more intuitive (Miller, 1987; Riding and Cheema, 1991).

The construct validity of the convergent-divergent dimension further predicts that those who are more fluent on open-ended tests are also likely to produce more original responses. Hudson (1967) found that divergers were three times more likely than convergers to produce a rare response on the object uses test, that is, a response produced by only 1% of the sample or less ( $p < 0.001$ ,  $N = 248$ ), and twice as likely to produce unusual responses, that is, those produced by less than 10% of the sample but more than 1% ( $p < 0.005$ ,  $N = 248$ ).

### **7.3.1 Design and participants**

Fifty-six psychology undergraduates (nineteen male, thirty-seven female), with a mean age of 23.62 years (Standard deviation 7.358 years), completed the revised convergent and divergent thinking tests. Thirty-nine out of fifty-six (nine male, thirty female) also completed the CSI instrument (Allinson and Hayes, 1996).

Participants completed the CSI instrument first, followed by the timed convergent-divergent tests. Presentation of the convergent and divergent tests was counterbalanced and a 7.5-minute time limit was imposed on each test.

### **7.3.2 Measurements:**

#### ***Convergent and Divergent thinking tests***

The revised convergent thinking test was constructed using two subtests taken from Daughtrey's (1993) collection of verbal reasoning test papers. The first section required connections to be made between words, based on category judgements, and contained 7 items; the second section required the identification and use of patterns

to complete a word pair, this section contained eight items, see Figure 7.6. The items used were not the same as in the previous study but were matched for difficulty level.

Daughtrey (1993) imposed a fifty-minute time limit per one hundred-item test; therefore, a limit of seven and a half minutes was applied to this fifteen-item test. Each item was awarded two points producing possible scores ranging from zero to thirty.

**Section 1:**

There is a connection between the three words on the outside of the brackets and TWO of the words inside the brackets. Underline the two words. Here is an example:

Giraffe Monkey Elephant      (Pig Hen Cheetah Dog Lion)

**Section 2:**

Write in the brackets the word needed to complete the third pair of words. This pair follows the same pattern as the first two pairs of words. Here is an example:

Laden, Lead: Baker, Beak: Pater ,(Peat )

**Figure 7.6: Examples of convergent thinking test items in each section**

The divergent thinking test was constructed using two out of five items from the ‘object uses test’, the objects were different from those used in the previous study;

and an attribute task requiring participants to generate words beginning with 'W', again the attribute 'W' was different to the 'T' used in the previous study, see Figure 7.7.

A time restriction of 7.5 minutes was imposed in which to produce as many responses as possible. Fluency was measured by awarding one point for each given response, with higher scores indicating greater fluency and, therefore, relatively more divergent thinking.

<p><b>Section 1:</b></p> <p>Below are two everyday objects. Think of as many different uses as you can for each:</p> <p>A blanket</p> <p>A brick</p> <p><b>Section 2:</b></p> <p>List as many words as you can think of beginning with the letter W.</p>
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**Figure 7.7: Divergent test items**

***Cognitive Styles Index (CSI)***

The Cognitive Styles Index (CSI) (Allinson and Hayes 1996) is a thirty-eight item self-report instrument, to which respondents must indicate a true, uncertain or false response. The test identifies an individual's cognitive style as being either analyst or

intuitive. The term intuitive is used to describe an individual who makes judgements based on feelings and who adopts a global approach to processing information, whereas the term analytic describes an individual who makes judgements based on reason, and who focuses on specific detail when processing information.

Twenty-one statements relate to the analytic pole and seventeen relate to the intuitive pole; true, uncertain and false responses are given 0, 1 or 2 points, respectively, and scores are reversed for intuitive items. The CSI has a theoretical minimum of zero and a theoretical maximum score of seventy-six, with a mean of thirty-eight. Lower scores indicate a more analytic cognitive style and higher scores indicate a more intuitive style.

The psychometric properties of this instrument are documented in Allinson and Hayes (1996). From a sample of 1000 participants, they reported a mean score of 38.5 and scores were normally distributed. Test-retest reliability of the instrument is also sound ( $r = 0.90$ ,  $p < 0.001$ ) taken for a subgroup of the whole sample of 1000, and mean scores of 34.60 (SD = 11.94) and 35.40 (SD = 12.10) indicate no significant changes over time ( $t = 0.82$ ,  $p > 0.05$ ). Finally, internal consistency scores measured by Cronbach's alpha taken from seven independent samples range from 0.84 to 0.92.

### **7.3.3 Results**

#### ***Discriminatory Power of the convergent tests***

The distribution of participant scores on the convergent and divergent tests were analysed to assess the discriminatory power of the tests.

The convergent test is in two sections; the first section requires connections to be made between words, based on category judgements, and contains seven items; and,

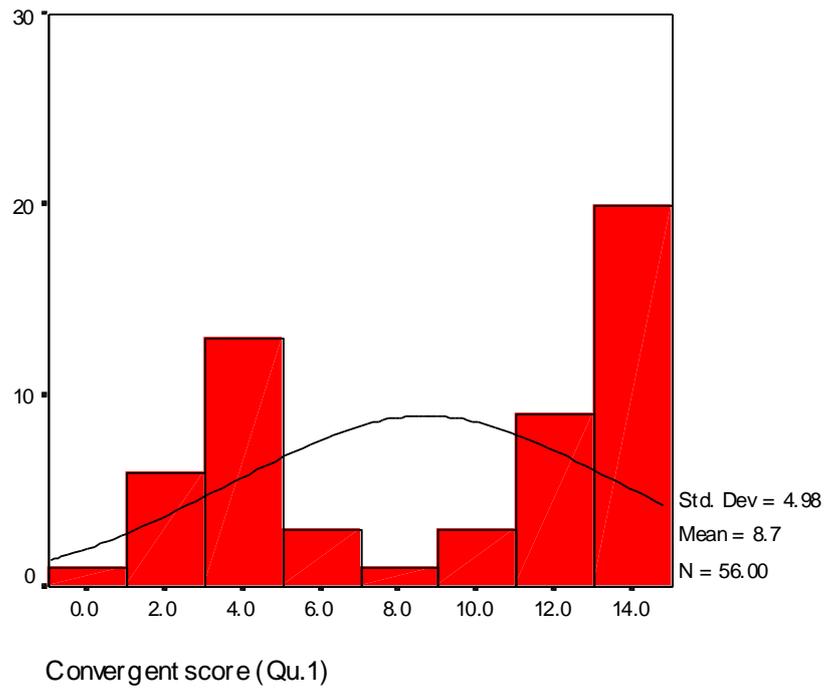
the second section requires the identification and use of patterns to complete a word pair, this section contains eight items. Each correct answer is awarded two points.

The mean score for section one was 8.66, slightly above the theoretical mean of seven; however, mean for section two was 13.61, which was closer to the theoretical maximum. Standard deviation for both was very similar; means of 4.98 and 4.55, respectively, see Table 7.4.

A one sample Kolmogorov-Smirnov Z test revealed that participant scores fell significantly outside normal distribution for convergent section one ( $Z = 1.726$ ,  $p = .005$ ); and, for convergent section two ( $Z = 2.663$ ,  $p < .001$ ). Participant scores were skewed to the right, see Figures 7.8 and 7.9.

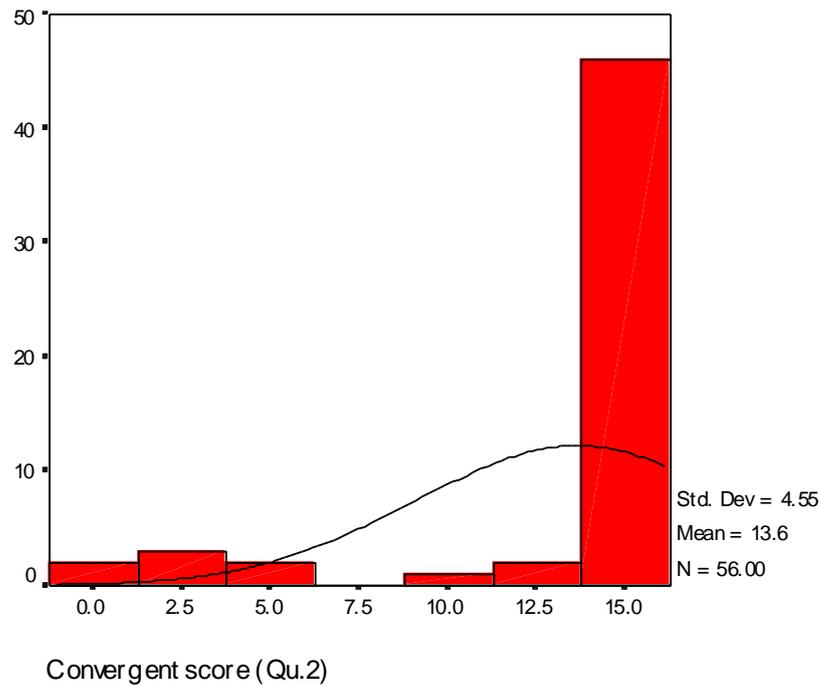
**Table 7.4: Mean and distribution of convergent test scores**

	<b>Section 1: Category Judgements</b>	<b>Section 2: Word pair patterns</b>	<b>Total:</b>
<b>Mean</b>	8.66	13.61	22.30
<b>Median</b>	11.00	16.00	24.50
<b>Standard dev.</b>	4.98	4.55	7.42
<b>Range</b>	14	16	26
<b>Kol.-Smirnov Z</b>	1.726	2.663	1.428
<b>Sig. (2-tailed)</b>	.005	.001	.034



**Figure 7.8: Scores for convergent section one - Category Judgements**

Figure 7.8 shows a distribution skewed to the right; 27 participants (48.21%) scored in the highest 25%, scoring 12 or above. 17 participants (30.36%) scored in the lowest 25% scoring 4 and below. The remaining 12 participants (21.43%) scored within the intermediate 50% range of scores.

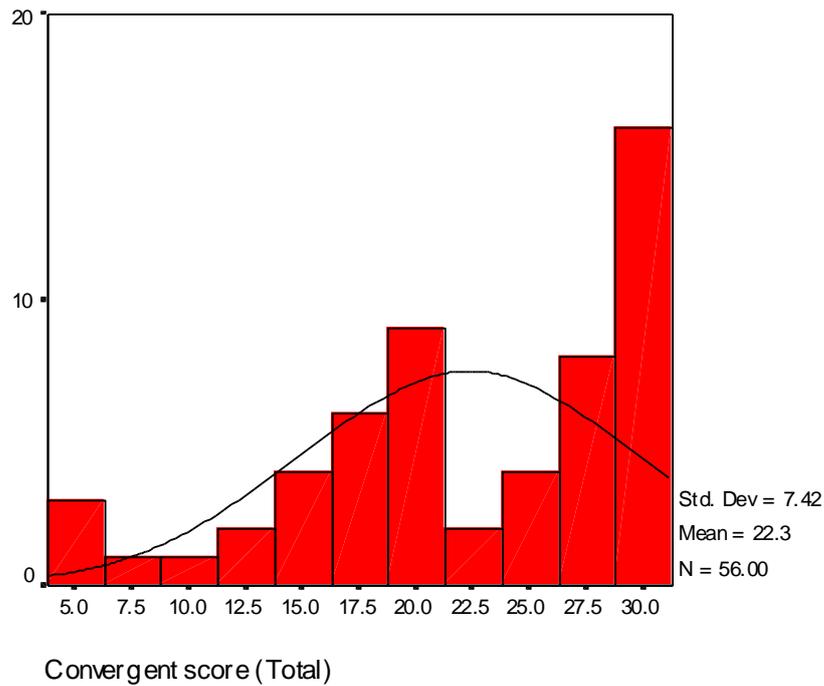


**Figure 7.9: Scores for convergent section two – Word pair patterns**

Figure 7.9 shows that the word pair tasks in section two was subject to floor effects; 34 participants (60.71%) scored the theoretical maximum of 16. This does not replicate the findings in the previous study, in which word pair task scores showed normal distribution.

When the convergent section scores were combined, see Figure 7.10, thirty participants (53.57%) scored in the highest 25% (scores ranging from 29-30), four participants (7.14%) in the lowest 25% (range 4-18) and the rest in the intermediate 50% range of scores.

The limited distribution of scores on both sections suggests that the majority of participants performed well on the convergent test, indicating that these tasks did not present sufficient challenge to produce a normal distribution of scores.

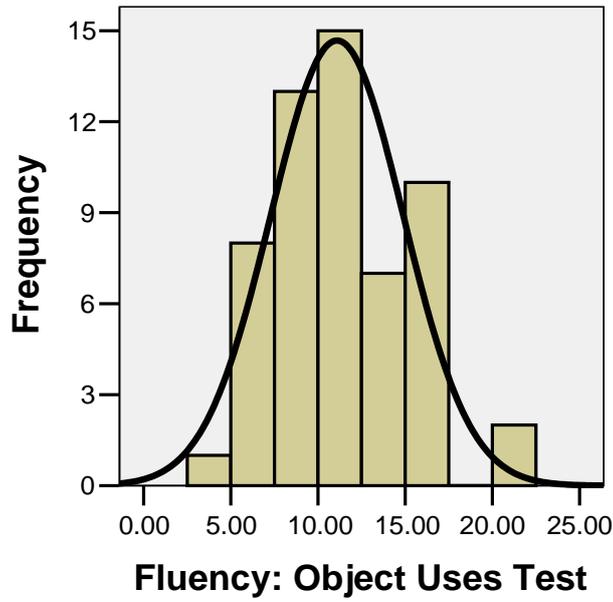


**Figure 7.10: Participants overall convergent scores**

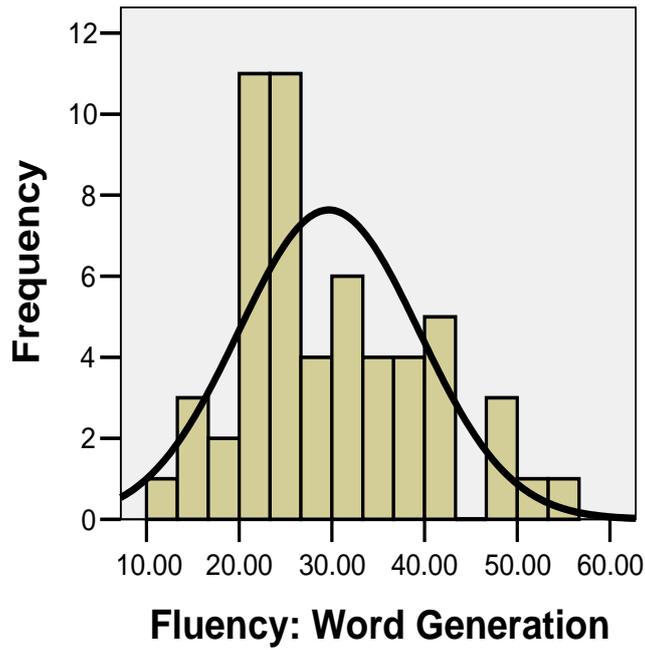
A Pearson correlation revealed a weak positive correlation between scores on convergent section one and two (.199), this correlation is not significant ( $p=.141$ ). The lack of variation in section one scores may account for the lack of a relationship between the convergent test sections.

***Discriminatory Power of the divergent tests***

Fluency of response to the divergent test was measured by awarding one point for each given response; higher scores indicate more responses generated and therefore greater ideational fluency. A series of one sample Kolmogorov-Smirnov Z tests revealed satisfactory Z scores for measures of fluency for sections one and two ( $Z = .758$ ,  $p = .613$ ;  $Z = 1.100$ ,  $p = .161$ , respectively) and overall divergent scores ( $Z = 1.1156$ ,  $p = .138$ ). Therefore, participants' scores were approximately normally distributed see Figures 7.11 and 7.12.



**Figure 7.11: Distribution of ideational fluency scores on Section 1: Object uses Test**



**Figure 7.12: Distribution of ideational fluency scores on Section 2: Word Generation Task**

Fluency scores on section one, the object uses test, showed a significant, positive correlation with fluency on section two, the word generation task (.233,  $p=.042$ ), and both sections correlated with the fluency total score (.540 and .945, respectively,  $p<.001$ ). The low correlation between the divergent test sections is a concern; it is possible that vocabulary level and experience rather than divergent thinking mediates ideational fluency on the word generation task.

#### **7.3.4 Construct validity of the convergent-divergent thinking style measure**

Construct validity was assessed in two ways: first the ability of the convergent-divergent style measure to predict analytic-intuitive styles; and, second the ability of the convergent-divergent style measure to discriminate between original and common responses to open-ended test items.

##### ***Convergent-Divergent Style and Analytic-Intuitive Style***

In keeping with the unitary perspective of global-analytic style, the construct validity of convergent-divergent style dictates that convergers should produce more analytic scores on the CSI and divergers should produce more intuitive scores.

Convergent-divergent style was first categorised by assessing relative performance on the divergent and convergent thinking tests. Performance was standardised by computing z scores for the convergent and divergent tests. Participant's position on the convergent-divergent dimension was calculated by subtracting the convergent score from the divergent score; therefore, negative scores indicate relatively more convergent thinking and positive scores indicate relatively more divergent thinking. The lowest 30% were labelled 'convergers', the mid 40% as 'all rounders' and the highest 30% as 'divergers'.

Owing to the questions raised by the low correlations between the divergent sections and between the convergent sections, style categories were calculated based on all combinations of the divergent and convergent subtests.

**Table 7.5: Basis of convergent-divergent style calculations**

<b>Basis of Convergent-Divergent style categorisation</b>		<b>Convergers</b>		<b>Divergers</b>	
<b>Divergent Test</b>	<b>Convergent Test</b>	<b>N</b>	<b>Mean</b>	<b>N</b>	<b>Mean</b>
<b>Object Uses</b>	<b>Category Judgements</b>	15	-22.5	14	27.38
<b>Object Uses</b>	<b>Word Pair Patterns</b>	14	-24.33	13	21.5
<b>Word Generation</b>	<b>Category Judgements</b>	19	-25.33	18	10.87
<b>Word Generation</b>	<b>Word Pair Patterns</b>	18	-27.17	18	5

A series of Bonferroni corrected t-tests (one for each of the above style calculations) was performed to examine the effect of convergent-divergent style on CSI scores. Divergers were expected to be more intuitive and convergers more analytic.

Table 7.6 shows that when the object uses test is used as the basis for divergent thinking there is no significant difference between the CSI scores of convergers and divergers (effect sizes of 0.08 and 0.09); these findings remain the same when category judgements are used as the basis for convergent thinking ( $t = .182$ ,  $p = .857$ ) and when word pair patterns are used ( $t = .195$ ,  $p = .847$ ).

Contrary to expectations, when the style calculation is based on the word generation task, divergers are more analytic. This difference is approaching significance ( $p =$

0.71 and 0.72, 2 tailed) with moderately large effect sizes (0.76 and 0.77) and remains consistent whether category judgements or word pairs are used as the basis for convergent thinking.

**Table 7.6: Effect of Convergent-Divergent style on CSI scores**

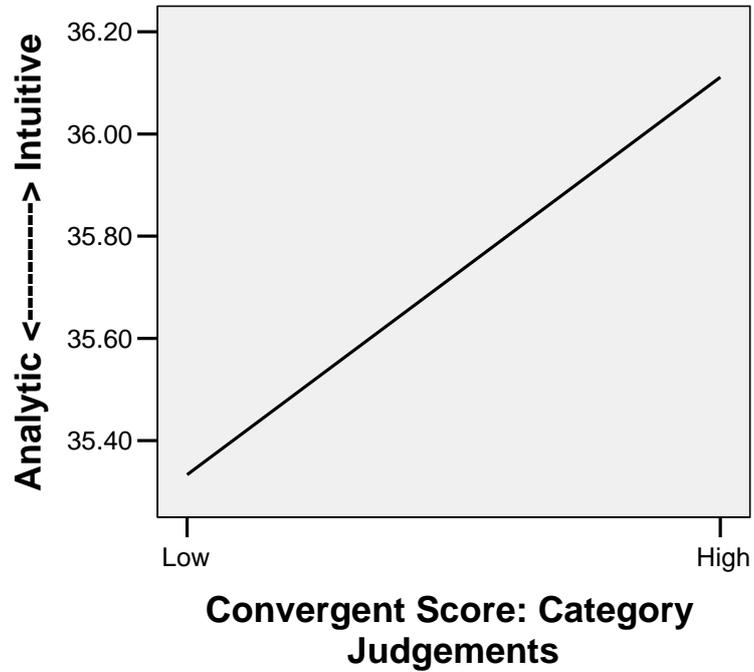
<b>Basis of Convergent-Divergent style categorisation</b>		<b>CSI Score:</b>		
<b>Divergent Test</b>	<b>Convergent Test</b>	<b>T-value</b>	<b>P-level</b>	<b>Effect size</b>
<b>Object Uses</b>	<b>Category Judgements</b>	0.182	.857	0.08
<b>Object Uses</b>	<b>Word Pair Patterns</b>	0.195	.847	0.09
<b>Word Generation</b>	<b>Category Judgements</b>	1.894	.071	0.76
<b>Word Generation</b>	<b>Word Pair Patterns</b>	1.890	.072	0.77

*2 tailed (  $p < 0.05$ ; corrected to  $p < .013$ ;  $p < 0.10$ , corrected top  $< 0.03$ )*

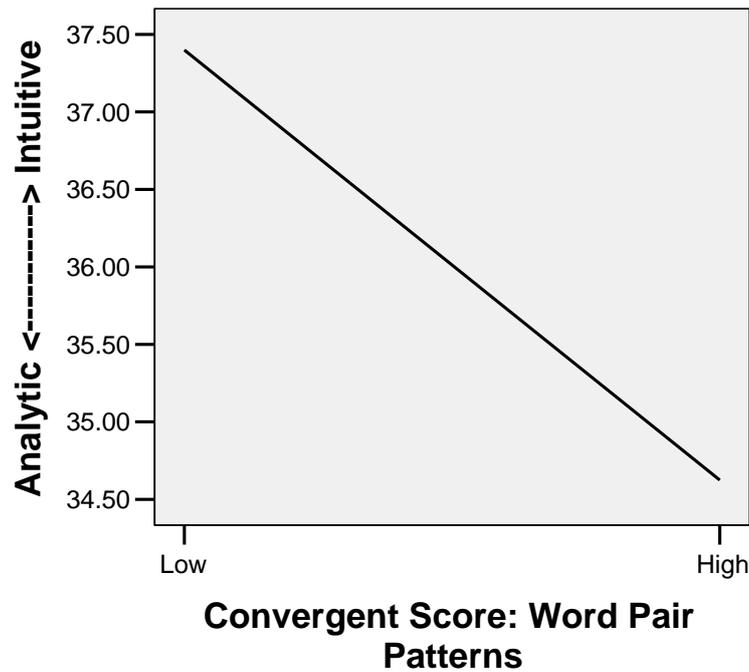
These findings suggest that individuals who are less fluent on the object uses test may spend more time on the relatively easier task of generating words which begin with ‘W’. This would explain the lack of correlation between the divergent subtests and explain why individuals who are more fluent on the word generation task are actually more analytic. The word generation task may also be influenced by verbal fluency and vocabulary experience.

Mediation of performance by task may also affect the convergent subtests. The word category task in section one draws on prior knowledge and experience whereas the word pair patterns in section two do not. There is some limited support for this

interpretation. Those who score in the highest 50% on the category judgement task produced a more intuitive CSI score than those in the lowest 50%; whereas, those who scored in the highest 50% on the word pair pattern task produced a more analytic CSI score than the lower 50%; see Figures 7.13 and 7.14.



**Figure 7.13: Effect of High and Low Convergent Section one scores on CSI scores**



**Figure 7.14: Effect of High and Low Convergent Section 2 scores on CSI scores**

### **7.3.5 Convergent-Divergent Style and Originality of responses**

Originality was measured by coding the frequency of each response in the sample and calculating the mean frequency of the 3 most original responses in the object uses test and the mean of the 10 most original responses to the word generation task. The minimum number of responses dictated the number of responses from which the mean was calculated across the sample. The mean of all responses was not used since originality would be confounded by fluent production of common responses.

The coding of responses was inevitably a subjective process; judgements were required as to how responses would be categorised based on frequency. For example, in the word generation task responses were grouped based on the word stem, i.e. want (frequency 25 of 1661), wanted (7 of 1661) and wanting (3 of 1661)

were considered to be the same word and given a combined frequency of 35. Without this grouping method 'wanting' would have been considered an extremely original response, which would not accurately reflect the data,

Coding the responses for the object uses test was less straightforward but equally necessary. Table 7.7 shows a sample of the uses that have been given for a blanket which have been grouped under two usage categories, decoration and fire blanket, and each given a frequency of 12.

24 categories were identified for uses for a brick and a further 20 responses were unique, e.g. 'paint it gold and sell it to someone who thinks its gold'; the most common uses for a brick were 'building construction' with a frequency of 103 out of 313 responses, and 'throwing/smashing' with a frequency of 32/313.

25 categories were identified for uses for blanket and a further 7 were unique, e.g. 'name for Michael Jackson's son'; the most common uses for a blanket were 'warmth' with a frequency of 52 in 312 and 'cover things' with a frequency of 35 in 312.

**Table 7.7: Sample of responses and example groupings for ‘uses for a blanket’**

Decoration	Fire blanket
“decoration”	“fire blanket”
“wall hanging”	“putting out fire”
“picture for walls”	“put under door to stop smoke getting in in a fire”
“decoration”	“covering a person during a fire”
“decoration”	“fire blanket”
“cut up into interesting designs”	“fire safety”
“decorate furniture”	“fire blanket”
“decoration”	“wet it and throw over someone on fire”
“a paint forum”	“putting out fire”
“sculpture”	“cover fire”
“displays”	“extinguish fire”
“artwork”	“save people”

A series of t-tests, Bonferroni corrected (one for each of the convergent-divergent style calculations) was performed to examine the effect of convergent-divergent style on the originality of responses to the open ended tests. Divergers were expected to be more original and than convergers, see Table 7.8.

The t-tests revealed that when the object uses subtest is used as the basis for the style calculation, divergers produce more original responses on the object uses test but not on the word generation task, with large effect sizes of 1.10 and 1.02.

**Table 7.8: The effect of Convergent-Divergent style on originality of responses**

Basis of style categorisation	Originality: Object uses			Originality: Word Generation		
	t	p	d	t	p	d
Object Uses and Category Judgements	2.439	.022	1.10	0.345	.733	0.13
Object Uses and Word Pair Patterns	2.249	0.34	1.02	0.656	.518	0.25
Word generation and Category Judgements	1.290	.205	0.47	4.491	<.001	1.62
Word generation and Word Pair Patterns	0.385	.703	0.12	5.253	<.001	1.88

2 tailed (Bonferroni correction:  $p < 0.05$  corrected to  $p < .013$ ;  $p < 0.1$ , corrected to  $< 0.03$ )

Conversely, when the basis of the calculation is the word generation task, divergers generate more original words but do not suggest more original uses for objects, again with large effect sizes of 1.62 and 1.88.

Those who produce more words on the generation task are likely to produce more original words by virtue of the fact that they have a longer list; this may also reflect verbal fluency and vocabulary rather than divergent fluency.

### 7.3.6 Discussion

The results suggest that the convergent-divergent thinking tests need further revision to increase the difficulty level and to examine the difference in the nature of the tasks.

The convergent subtests lacked discriminative power; the tests need to be more challenging. In addition to this, participant scores on each convergent subtest did not correlate; the absence of a relationship may be due to the lack of variation in scores, however, it may also be that the nature of processing required differs between the two subtests.

Convergent section one required word category judgements that relied on prior knowledge and experience; whereas, convergent section two involved identifying a pattern to produce a new word. Section two does not rely on prior knowledge and experiences; all the elements required to achieve the correct answers are provided. Therefore, the nature of the task in section two may represent a more pure test of convergent or analytic thinking.

The divergent subtests have sufficient discriminative power but the weak relationship between them also suggests that performance on each is mediated by something other than divergent thinking. The object uses test may represent a more valid measure of convergent-divergent style, particularly when a time limit is placed on completion. In this context convergers spend relatively less time on the object uses task and more time on the word generation task producing inconsistent results. Support for this interpretation was the fact that greater fluency and originality on the word generation task was linked with more analytic scores on the CSI. One solution would be to remove restrictions on completion time but this is undesirable since the limit is designed to be consistent with time limits on the convergent tests to ensure naivety during counterbalancing procedures.

The convergent-divergent tests should be adapted such that the convergent tasks are more difficult. A distinction should be drawn between convergent items, which may be mediated by prior knowledge or verbal ability and those task which are self contained, providing all the information needed to solve the tasks without the need

for prior knowledge. The divergent task will consist only of the object uses test; but the full 5 item test will be used rather than the shortened two item version used thus far.

#### **7.4 Construction and Validity of the revised Convergent and divergent thinking tests**

Based on the recommendations, which emerged from the previous study the convergent tests were revised to present a greater challenge to participants and the possible mediating influence of prior knowledge and experience was controlled by designed two categories of convergent task.

Two convergent tests were constructed; the ‘verbal convergent test’ (VCT) and the ‘non verbal convergent test’ (NVCT). The VCT contains verbal items, which may be mediated by prior knowledge and experience such as exposure to books and vocabulary experience. The NVCT consists of maths and spatial problems, which do not rely of prior knowledge because all the components needed to answer the questions, are contained within the test. Both convergent tests have been constructed from sections of the MENSA intelligence test (2004).

The VCT is constructed using two subtests from the MENSA intelligence test (2004). The first subtest has 16 items and requires identification of words from a list which are opposite or the same as target words, see Figure 7.15.

The second subtest has 8 items, which required identification of word pairs which are related in the same way as the example word pair, see Figure 7.16. Both words have to be underlined correctly to achieve the correct answer and demonstrate that the relationship has been identified; points are not awarded if only one of the correct words has been underlined.

Look at this list of words, each word has a number

- |          |           |          |
|----------|-----------|----------|
| 1. wide  | 6. empty  | 11. lazy |
| 2. end   | 7. swell  | 12. big  |
| 3. fast  | 8. over   | 13. long |
| 4. find  | 9. like   | 14. good |
| 5. right | 10. grand | 15. deep |

‘Quick’ means the SAME as ‘fast’, which is word No. 3, so we put:

quick means the SAME as word No. 3

‘Small’ means the OPPOSITE of ‘big’, which is word No. 12, so we put:

small means the OPPOSITE of word No. 12

**Figure 7.15: Verbal convergent test - Example of a word meaning task**

Look at this:

hat, head (face, hand, foot, dress, mouth, shoe)

A hat is worn on the head, and a shoe is worn on the foot, so ‘shoe’ and ‘foot’ are underlined.

**Figure 7.16: Verbal convergent test – Example of a word relationship task**

The NVCT is also constructed using two subtests from the MENSA test. The first subtest has 12 items and each presents a series of numbers which are in a logical order with one number in the series missing; the task is to complete the series by inserting the correct number, see Figure 7.17.

Look at these numbers:

3, 5, 7, ..., 11, 13, 15.

There is a gap where the number is left out.  
It is 9, so the numbers should be:

3, 5, 7, 9, 11, 13, 15.

Now these:

64, 32, 16, ..., 4, 2, 1.

The number left out is 8,  
So the numbers should be:

64, 32, 16, 8, 4, 2, 1.

**Figure 7.17: Non-verbal convergent test- Example of missing numbers task**

The second subtest has 10 items, each involves following instructions to identify a target letter in a letter square, see Figure 7.18.

Here is a letter square:

R J N Y K  
G E P U B  
M Q F T S  
O A H C V  
X L D W Z

See how the letters are arranged. Thus P comes after E. C is just below T. S is between B and V. Now answer the following:

What letter comes just above the letter just after H? \_\_\_\_\_

What letter comes just before the letter just above the letter between Q and T? \_\_\_\_\_

**Figure 7.18: Non-verbal convergent test – Example of Letter square task**

Each correct answer from the VCT and the NVCT is awarded one point; the VCT has a theoretical maximum of 24 and a mean of 12 and the NVCT has a theoretical maximum of 22 and a mean of 11. On both tests the items become increasingly more difficult as the test progresses. Each test has a 7.5-minute time limit.

The divergent test consists of the full 5 item Object Uses Test with a 15-minute time restriction, see Figure 7.19.

Below are five everyday objects. Think of as many different uses as you can for each:

A barrel

A paper clip

A tin of boot polish

A brick

A blanket

### **Figure 7.19: Object Uses Test**

The discriminatory powers of the newly revised tests were again examined and the construct validity of the convergent-divergent measure was considered in light of its ability to discriminate analytic-intuitive styles on the CSI.

#### **7.4.1 Design and Participants**

111 participants (36 male, 74 female, 1 not stated) completed the CSI, the verbal convergent test (VCT), the non-verbal convergent test (NVCT) and the object uses test. The samples mean age was 22.33 years with a standard deviation of 7.28 years (males = 22.69 yrs, s.d. 8.27 yrs; females = 22.15 yrs, s.d. 6.80 yrs). All participants completed the CSI first. Completion of the convergent and divergent tests was counterbalanced.

## 7.4.2 Results and discussion

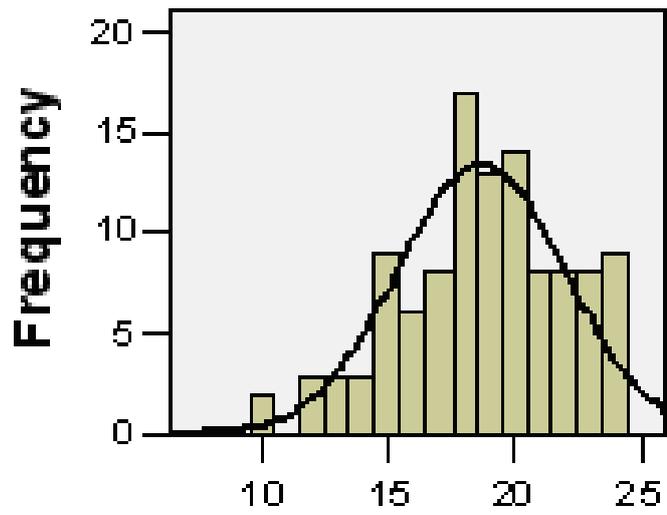
### *Discriminative power of the convergent-divergent test*

The distribution of scores on the convergent and divergent tests are summarised in Table 7.9.

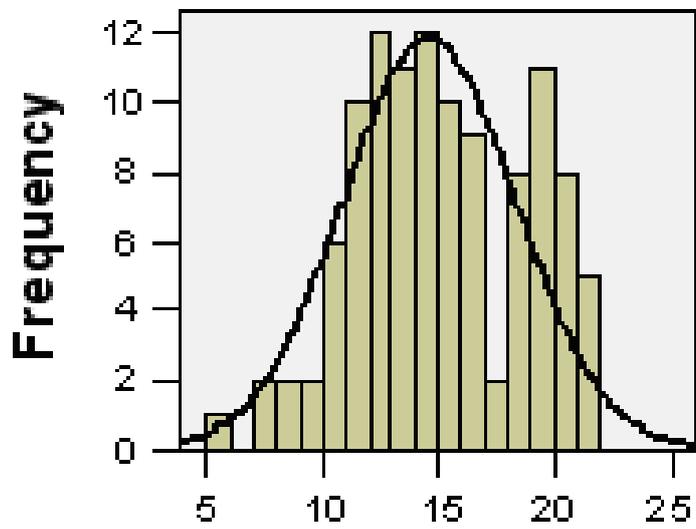
**Table 7.9: Distribution of Convergent and Divergent Scores**

Test	Mean	S. D.	Min.	Max.	Kol.-Smirnov	
					Z	P
Verbal Convergent Test	18.75	3.31	10	24	1.098	.179
Non-Verbal Convergent Test	14.66	3.75	5	22	1.077	.197
Divergent Test	18.79	5.68	8	40	1.059	.212

The convergent scores were approximately normally distributed; the tests were sufficiently difficult to produce a satisfactory range of scores, see Figures 7.20 and 8.21; however, the verbal convergent test was slightly skewed to the right with mean scores of 18.75, which is better than the theoretical mean of 12.

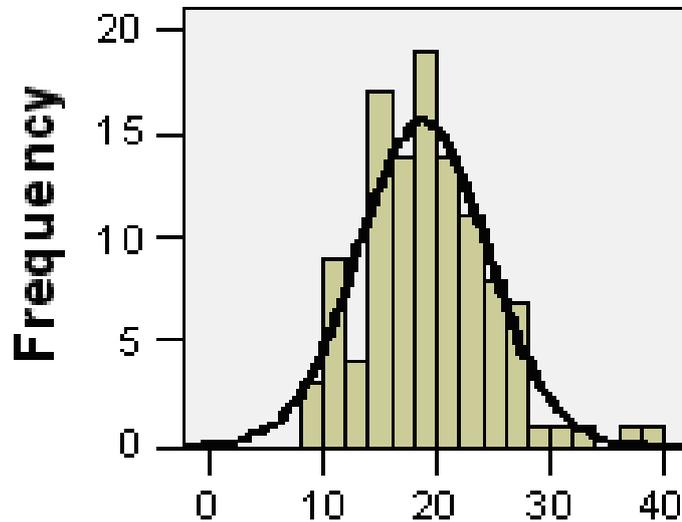


**Figure 7.20: Distribution of Verbal Convergent Test Scores**



**Figure 7.21: Distribution of Non-Verbal Convergent Test Scores**

The mean divergent score was 18.79; this is comparable to Hudson's (1967) sample mean of 16-17. The divergent test scores are approximately normally distributed see Figure 7.22.



**Figure 7.22: Distribution of Divergent Test Scores**

The divergent data was compared with Hudson's (1967) own data which was heavily skewed with a tail of high scores which reached up to the 50s, The current sample achieved maximum scores of 40 and an improved distribution, this may be because of the time limit imposed on the object uses test.

***Internal Consistency of the convergent-divergent test***

Performance on the verbal convergent test correlated with performance on the non-verbal convergent test ( $r = 0.56, p < .001$ ).

Participants were categorised as Converger, all rounder or Diverger based on their divergent score with their VCT score and based on their Divergent score and their NVCT. The consistency of the style categorisations was assessed, see Table 7.10.

**Table 7.10: Comparison of style categories based on the VCT and the NVCT**

<b>Divergent test with Non-Verbal Convergent Test</b>	<b>Divergent test with Verbal Convergent Test</b>		
	<b>Convergers</b>	<b>All rounders</b>	<b>Divergers</b>
<b>Convergers</b>	26	8	2
<b>All rounders</b>	13	19	12
<b>Divergers</b>	2	6	23

The observed frequencies of the style labels are significantly greater than those expected by chance ( $X^2 = 49.143$ ,  $p < 0.001$ ). There is a consistent relationship between the convergent-divergent style labels produced when the divergent test plus the VCT is the basis of the classification and when the divergent test and the NVCT is the basis ( $r = 0.62$ )

The consistency increased when the convergent tests are combined and the style classifications are based on the divergent test plus the VCT and the NVCT. The correlation between the combined measure and the measures which employ the VCT or the NVCT are  $r = 0.78$  and  $r = 0.87$ , respectively.

**Table 7.11: Consistency of convergent-divergent style labels when the VCT and the NVCT combined**

Divergent test with VCT plus NVCT	Divergent with NVCT			Divergent with VCT		
	Converger	All Rounder	Diverger	Converger	All Rounder	Diverger
<b>Converger</b>	30	3	0	29	3	1
<b>All Rounder</b>	6	36	3	12	25	8
<b>Diverger</b>	0	5	28	0	5	28

***Construct Validity: Convergent-Divergent Style and Analytic-Intuitive Style***

Participants were classified as analytic, intermediate or intuitive by creating two equal cut points in the CSI scores, see Table 7.12.

**Table 7.12: CSI Classification by sex and age**

CSI Label	Age		Sex (N)		CSI Score		
	Mean	Standard Deviation	Male	Female	Min	Max	Mean
<b>Analytic</b>	22.73	5.35	11	26	47	68	54.62
<b>Intermediate</b>	23.37	8.74	13	24	37	46	41.74
<b>Intuitive</b>	21.41	7.91	10	27	11	36	28.41

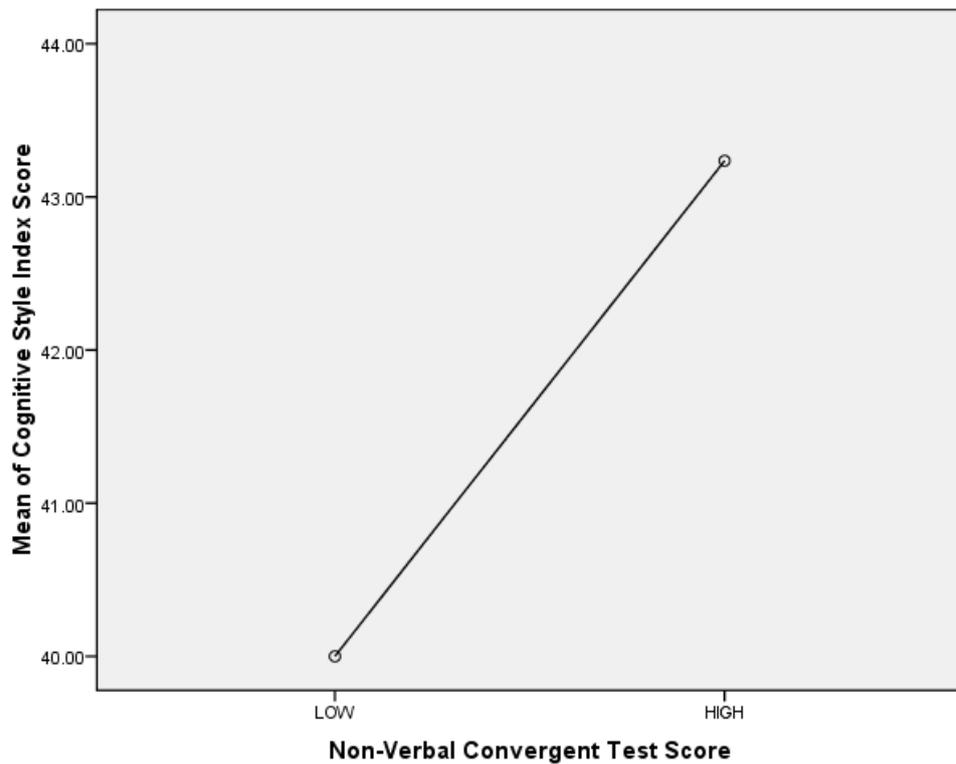
A one-way ANOVA was used to assess the effect of Analytic-Intuitive style on the convergent and divergent thinking tests. There was no significant effect of style on any of the tests indicating that there is no overall difference in ability on divergent or convergent type tasks between analytics, intermediates and intuitives.

**Table 7.13: Effect of Analytic-Intuitive style on convergent and divergent thinking tests**

CSI Label	Divergent Fluency		Verbal Convergent Test		Non-Verbal Convergent Test	
	Mean	S.d.	Mean	S.d.	Mean	S.d.
<b>Analytic</b>	19.00	6.27	19.14	3.01	14.84	4.53
<b>Intermediate</b>	17.65	5.71	18.34	3.79	14.34	3.39
<b>Intuitive</b>	19.89	5.05	18.92	3.13	15.05	3.38

However, in the previous study one of the findings, which approached significance, suggested that participants who scored in the highest 50% on convergent tasks that do not rely prior knowledge and vocabulary experience also produce more analytic scores on the CSI.

This finding was replicated here; the highest scoring 50% on the non-verbal convergent test were more analytic than the lowest scoring 50%, means of 40.00 and 43.24, respectively. This finding approached significance ( $t = -1.452$ ,  $df = 110$ ,  $p = .075$ ). The effect size was small (0.27). There was no significant difference between the CSI scores of high and low performers on the verbal convergent test.



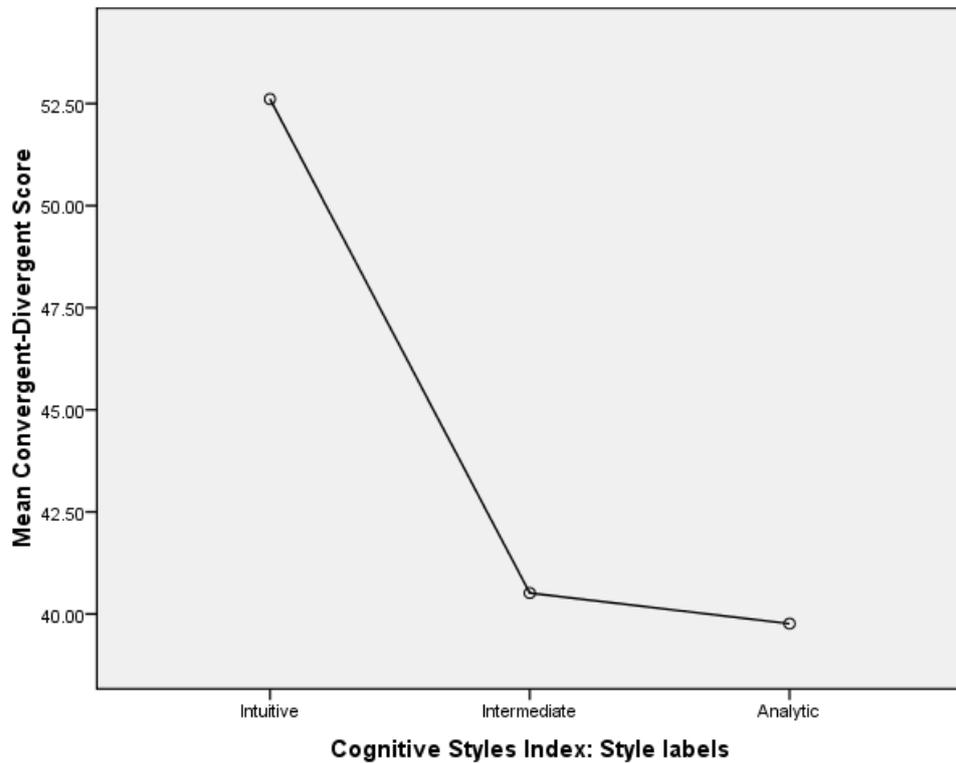
**Figure 7.23; Effect of high and low Non-Verbal Convergent Test Scores on CSI scores**

The unitary perspective of global-analytic style suggests that convergent individuals should be more analytic than divergent individuals.

Convergent-Divergent Style was assessed by subtracting the standardised performance on the convergent thinking tests from the standardised performance on the divergent thinking test. High scores on the convergent-divergent measure indicate divergent style and lower scores indicate convergent style.

Next, a one-way ANOVA was used to assess the effect of Analytic-Intuitive Style on convergent-divergent style scores. The Intuitives produced a higher mean

convergent-divergent score indicating a more divergent style, however, this effect was not statistically significant ( $F_{2, 108} = 0.448, p = .640$ )



**Figure 7.24: Effect of Analytic-Intuitive style on convergent-divergent style**

### 7.4.3 Discussion

The verbal and non-verbal convergent tests had discriminative power, suggesting that they are now sufficiently challenging to present a useful spread of scores and they have demonstrated internal consistency. The divergent test has also demonstrated a good spread of scores which are comparable to those produced by Hudson's (1967) original research.

When the convergent tests were combined with performance on the object uses test they provided a valid basis for assessing convergent-divergent style. The convergent–divergent style classifications have demonstrated internal consistency across the verbal and non-verbal forms of the convergent test.

The inclusion of verbal, knowledge based items and non-verbal, knowledge free items will allow experimental control over the possible mediating influence of prior knowledge and experience. However, it is acknowledged that even the non-verbal test items have a substantial verbal component in the form of the verbal instructions, and the mathematical sequence tasks and letter square items have been presented in verbal format. The reliance on verbal presentation of tasks may well affect the performance of respondents with language based disorders however since convergent-divergent style is assessed by an individuals relative performance on convergent and divergent tasks, which all rely heavily on verbal presentation, difficulties with verbal content should be controlled for.

This concludes the development and validation phase of the convergent-divergent style measure; the measure will be employed in Chapter eleven to assess the construct validity of the wholist-analytic dimension by addressing the assumption that styles in the wholist-analytic family should correlate with each other.

**Chapter 8:**  
**Construction and Validation**  
**of the Computer Based**  
**Matching Familiar Figures Test**

## **Chapter 8: Construction and validation of the computer based Matching Familiar Figures Test**

### **8.1 Chapter Introduction**

In a series of studies reported in the early sixties Jerome Kagan searched for the determinants of analytic versus global processing preferences such as those described by Witkin (Kagan et al., 1964). Kagan and colleagues noted links with analytic processing and longer response times, which led them to propose the reflective-impulsive style dimension. They considered reflective-impulsive style to be a more fundamental process and one of the determinants of the production of analytic concepts.

Kagan, Moss and Sigel (1963) tested school aged children on their performance on the Conceptual style test (CST). The CST presents three pictures and the respondent is required to choose two, which go together and state why. There is no right or wrong answer; respondents are scored based on the types of concepts used to link two of the stimuli, which may be analytical, relational or inferential-categorical. For instance if the pictures are of two shirts, one striped and one plain, and a zebra, one child may group the two shirts together, employing an inferential-categorical classification based on the fact that they are both items of clothing; another child may group the zebra and the striped shirt, employing an analytical classification based on an attribute of the stimuli, in this case the stripes. In another example, the three pictures could be a watch, a man and a ruler; an analytical pairing may be ‘the numbers on the watch and the ruler’ whereas a relational pairing may be ‘the man wears the watch’.

Kagan et al. (1964) found that some children showed a preference for providing analytical classifications that is, grouping stimuli based on their component parts

rather than by category or functional relationship; and that a tendency to produce analytical pairings was associated with a tendency for slower conceptual decision-making. The tendency to produce analytic concepts in the CST was also related to faster solution times on the Hidden Figures Test (HFT). The hidden figures test is conceptually very similar to the embedded figures test (EFT), particularly the childrens' EFT and these results unsurprisingly provide a link between the tendency to analyse a visual array into its component parts and the ability to disembed a figure from a complex background.

Additionally, boys who produced more analytic concepts on the CST respond with a lower number of incorrect choices on the HFT than low analytic boys, even when boys were matched for their solution times on the HFT, therefore, controlling for disembedding ability. The findings suggested that analytic boys had a greater disembedding ability and were better at inhibiting incorrect responses.

Next Kagan and his team examined the possibility of increasing the production of analytic concepts on the CST and increasing accuracy of the first responses to the delayed recall test (DRT) and the HFT by encouraging participants to respond more slowly. It was the results of this study, which resulted in the proposition of a reflective-impulsive style variable and led to the design of the matching familiar figures test (MFFT).

Kagan found that when participants were instructed to respond as quickly as they could, they produced fewer analytic concepts on the CST and more incorrect responses on the DRT and the HFT; conversely when they were instructed to take their time and think about their answer they produced more analytic concepts in the CST and were more often correct on the first response in the DRT and the HFT. The Wechsler intelligence scales for children (WISC) vocabulary scores were not affected by slow or fast instruction set. Further, response times were significantly

longer in the slow instruction condition as would be expected and were independent of WISC vocabulary scores in both instruction conditions.

Kagan suggested that reflectivity-impulsivity and the tendency to analyse visual arrays are more fundamental processes and are the primary determinants of the production of analytic concepts. Kagan and his team argued that the tendency to reflect over alternatives and the tendency to analyse visual arrays into component parts are independent processes but they both influence accuracy in perceptual recognition tasks.

When faced with a timed test in which there are more items to answer than can be completed within the time limit, individuals will tend to approach such a test in a fairly consistent manner. An individual with a reflective cognitive style would answer fewer items, taking more time to ensure accuracy. An “impulsive” individual would answer more items to the detriment of accuracy. The impulsivity-reflectivity construct appears to be relatively stable over time and tasks (Sternberg, 1997).

The Matching Familiar Figures Test (MFFT) is the traditional measure of reflectivity-impulsivity. The MFFT presents a complex figure and requires participants to select which, of six complex figures, is an identical match with the presented figure. Reflective individuals are expected to have relatively longer response times with relatively fewer errors; impulsive individuals are expected to respond relatively quicker with relatively more errors. The MFFT was designed to provide a level of complexity, which induces response uncertainty and presents a fixed set of response alternatives from which to choose. The scoring is based on latency to first response and the number of incorrect responses offered.

It is the response uncertainty and the scoring method which characterise the MFFT as a measure of reflection-impulsivity rather than the specific nature of the task stimuli;

however, Zelniker and Jeffrey (1979) have provided evidence that the task itself may favour local rather than global processors.

Zelniker and Jeffery suggested that reflective individuals have a preference for local processing and impulsives for global processing; to test this hypothesis they modified the MFFT to include either meaningful figures or abstract figures, meaningful figures were predicted to encourage global processing. They also manipulated global or local differences; In half of the trials, the differences between the matching figure stimuli were in the contours of the figure which favoured global processing and in the other half the differences were in the detail within the figure which favoured local or part processing.

Zelniker and Jeffery's reflective group by definition had longer response latencies and a lower number of errors overall but the difference in error responses manifested from the local stimuli not the global stimuli. This means that when the differences between the alternative figures was in the detail rather than the contours of the shape reflective individuals were more accurate than impulsives; but when the differences were in the contours, impulsives became significantly more accurate and reflectives became significantly less accurate leaving no significant difference in accuracy of performance on global stimuli.

In addition to this, the meaningful stimuli but not the abstract stimuli resulted in longer response latencies to the local stimuli but not to the global stimuli. The implication being that when the task requires local processing the meaningful stimuli which evokes global processing causes interference producing slower responses. Even more interestingly, a three-way interaction between style, task and meaning revealed that the meaningful figures slowed down the reflectives responses to local stimuli but not the impulsives. This implies that the impulsives already have a tendency to process globally leaving them uninfluenced by the meaningful figures

whereas the reflectives tendency to use local processing was hampered by the influence of meaning and the global processing it evoked.

Zelniker and Jeffery were concerned only with the characteristics associated with reflective-impulsive style but their findings appear to have wider implications for the validity of the MFFT. If reflective individuals are characterised by a tendency to use local processing then the meaningful stimuli used in the MFF is likely to increase their response latencies and the predominance of local rather than global differences in the MFFT is likely to increase their accuracy. Therefore the MFF may be confounded by measurements of local and global processing preferences because of the nature of the tasks employed.

The MFFT has also been shown to have low internal stability, specifically relating to error scores (Ault, Mitchell and Hartman, 1976) and in response to such findings a revised version of the MFFT has been devised, the MFFT-20 which has demonstrated greater internal stability and much improved test-re-test reliability (Cairns and Cammock, 1978; Buela-Casal, Carretero-Dios, Santos-Roig and Burmudez, 2003); despite this, it is the original version of the MFFT which is generally employed in comparison studies not the psychometrically improved MFFT-20 (e.g. Riding and Dyer, 1983; Jamieson, 1992; Allinson and Hayes, 1996). Having said that, the original MFFT has provided normative data in relation to adult samples (Salkind, 1978) whereas the MFFT-20 seems most reliable when used with children between the age of six and twelve years; samples aged six and under or twelve and over have suffered from floor and ceiling effects, respectively (Carretero-Dios, Macarena and Buela-Casal, 2008)

The MFFT is designed to be administered individually by showing a series of twelve A4 size cards with a standard familiar figure and eight response options, one replicates the standard exactly and the others have small differences. The participant must choose the correct match, if they make an incorrect choice they are told that the

183

response is incorrect and they should choose again. The experimenter times the latency to first response with a stopwatch and records the number of incorrect choices made per trial. Using a median split method, reflective individuals are those who have longer average response latencies but fewer incorrect responses; impulsives are those who have faster than average response times but produce more incorrect responses. The remainder of the respondents are either fast and accurate or slow and inaccurate.

A computer version of the MFFT was constructed to improve the precision of the timing of latencies and to allow group administration of the MFFT. The present study outlines the construction and validation of the replica computer form of the MFFT.

## **8.2 Method**

### **8.2.1 Participants**

70 participants (21 males, 49 females) with a mean age of 22.24 years (standard deviation 6.83 years) completed the computer MFFT in groups of between fifteen to twenty-eight people. Participants were approached during a weekly workshop and received course credit for taking part.

### **8.2.2 Construction of the computer based matching familiar figures test**

The test is a replica computer version of Kagans' 'Matching Familiar Figures' test. Participants are required to try two practice items before completing the twelve trial items. In each case participants are presented with a familiar figure and their task is to choose which figure matches it perfectly from a set of alternatives, there are six

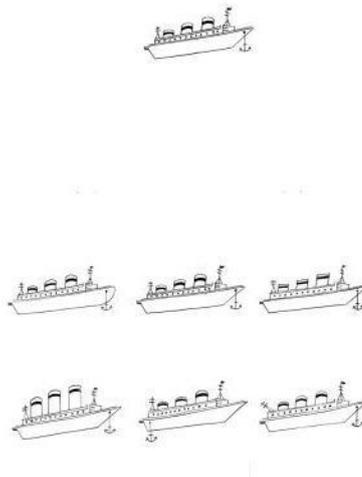
184

alternatives in the practice items and eight in the trial items. If the incorrect figure is selected then the participant must try again until the correct figure is selected.

Latency to the first response on each trial and the number of attempts per trial were recorded. The median participant reaction time was calculated and the total number of attempts per trial to achieve accuracy. Allocation of style labels was based on the median split method, participants with the fastest reaction times and the highest number of attempts were labelled as impulsive and the slowest reaction times and the lowest number of attempts were labelled reflective. Standardising the median latency and the number of errors into z scores produced a continuous reflective-impulsive score; standardised error scores were reversed and added to standardised median latencies producing a scale in which high scores indicate reflective styles and low scores indicate impulsive styles.

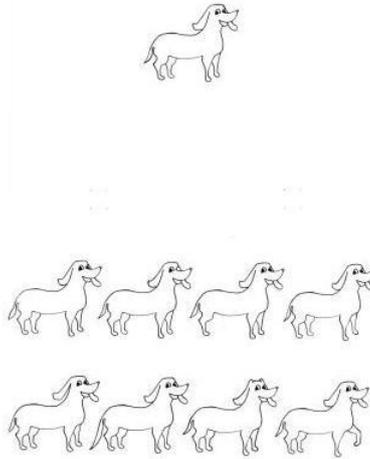
### 8.2.3 Stimuli

Two practice trials were presented, the first featured a boat with six response alternatives and the second featured a cowboy. The boat stimulus is shown in Figure 8.1. All stimuli are scanned copies of the original stimuli.



**Figure 8.1: Practice item one – Boat with six response alternatives**

The twelve trial items presented a dog, a rose, a soldier, a graph, a baby, a lamp, a dress, a lion, a pair of glasses, a plane, a leaf and a bed. An example of the first trial stimuli is shown in Figure 8.2.



**Figure 8.2: Trial item one – Dog with eight response alternatives**

#### **8.2.4 Instructions**

Standardised computer presented instructions were employed; no verbal instruction was provided prior to the test. On screen practice instructions are shown in Figure 8.3, trial instructions are shown in Figure 8.4. Participants were required to click the mouse over the figure, which they think represented a perfect match. Incorrect responses received onscreen feed back “ incorrect, try again”

You will be shown a picture of a familiar item and some pictures that look like it.

You will have to click on the picture that is a perfect match.

TRY A COUPLE OF EXAMPLES FIRST.

CLICK TO PROCEED

**Figure 8.3: Practice instructions**

Ready to begin the test?

These are a bit harder - you will see a picture on top and eight pictures on the bottom

Click on the picture that is the perfect match

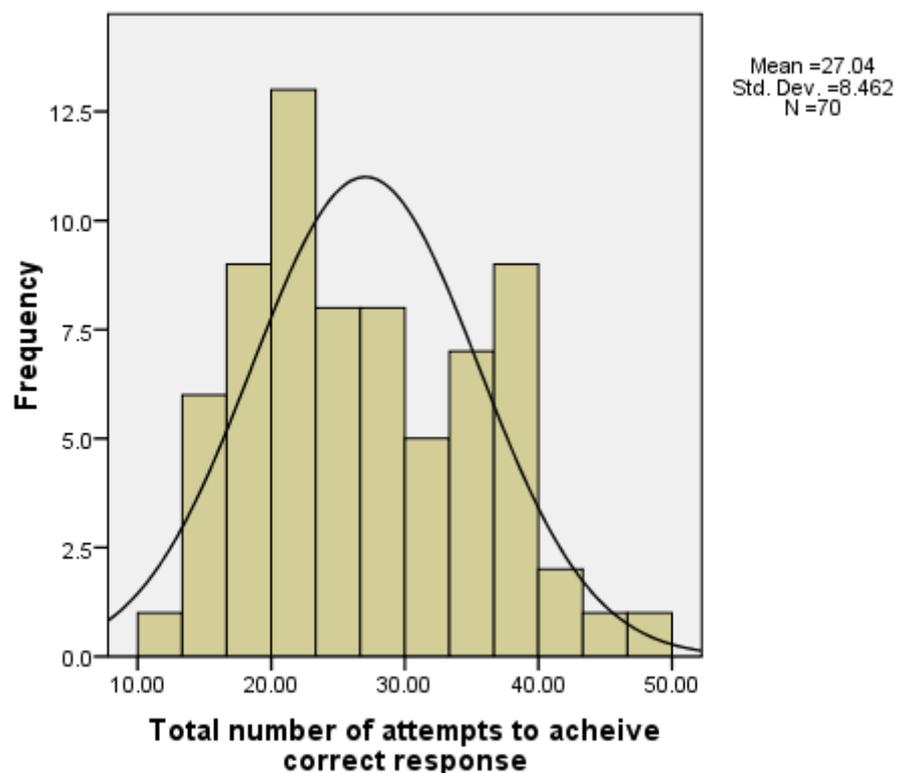
CLICK TO BEGIN

**Figure 8.4: Trial instructions**

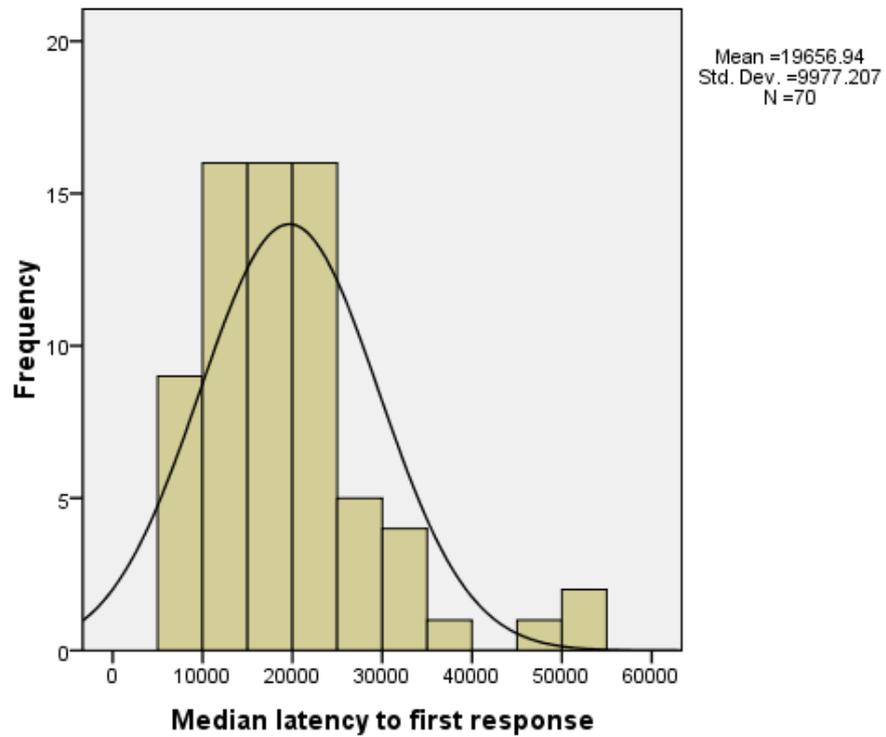
### 8.3 Results

#### 8.3.1 Discriminatory power

Accuracy scores were normally distributed ( $z = .819$ ,  $p = .514$ ) with a minimum score of 13 indicating a near perfect score and a maximum score of 48 suggesting that some participants regularly clicked on four of the eight figures before happening upon the correct answer reducing the odds of eventually making the right choice to 50-50. See Figure 8.5. Latencies were normally distributed ( $z = .949$ ,  $p = .328$ ). The normal range for responding was between 6 second and 35 seconds; there were 4 extreme scores with responders taking on average close to a minute to make their choice (minimum and maximum median latencies, 5815ms and 54587ms, respectively). See Figure 8.6.

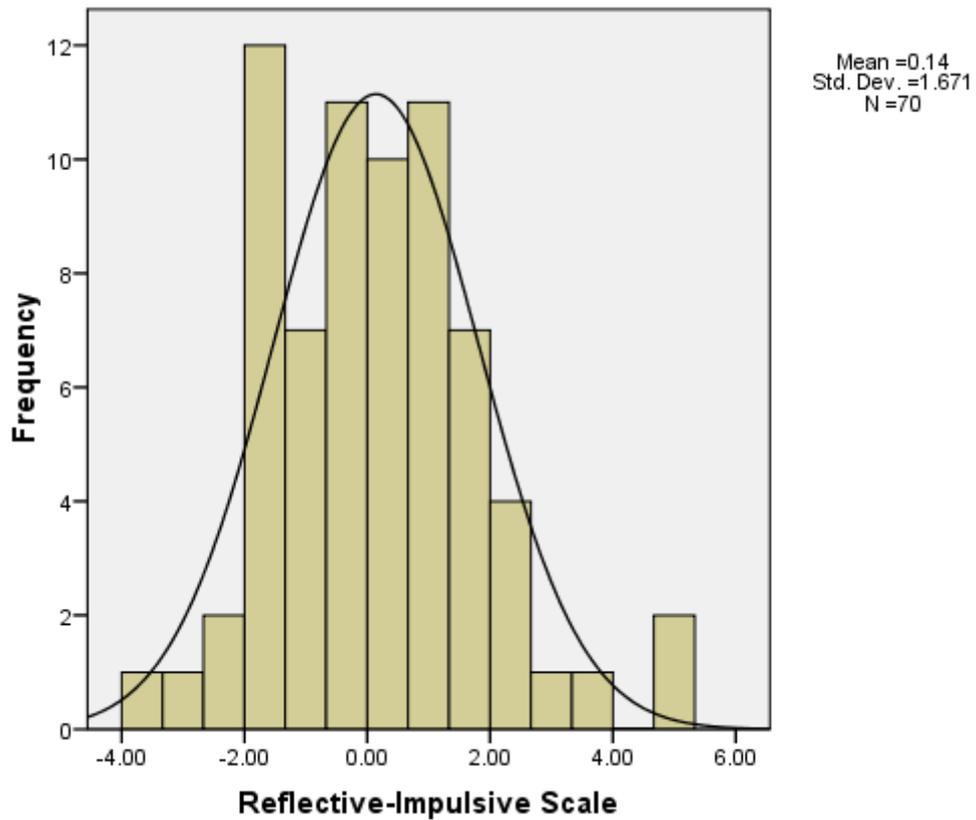


**Figure 8.5: Distribution of number of responses to achieve accuracy**  
188



**Figure 8.6: Distribution of median latencies to first response**

The median latencies to first response and the number of errors made on the matching familiar figures test were standardised as *Z* scores, standardised error scores were reversed and summed with standardised latency scores to produce a scale in which high scores represent reflective style and low scores represent impulsive style; fast-accurate and slow-inaccurate participants should achieve intermediate scores. Reflective-impulsive scale scores were also normally distributed ( $z = .587, p = .881$ ) see Figure 8.7.



**Figure 8.7: Distribution of reflective-impulsive style scores**

### 8.3.2 Internal consistency

A Pearson correlation showed that ‘latency to first response’ and the ‘number of errors made before the correct answer was achieved’ negatively correlated ( $r = -.485$ ,  $p < .001$ ,  $n = 70$ ) demonstrating that the longer reflection times lead to greater accuracy.

An inter item analysis produced Cronbach’s alphas of .56 for accuracy and .91 for latencies. Split half reliabilities based on odd and even trials produced correlations of  $r = .47$  for accuracy and  $r = .83$  for latency.

Split half reliability comparing reflective-impulsive scales calculated from odd and even trials produced correlations of  $r = .74$ .

### 8.3.3 Reflective–impulsive style classifications

Reflective and impulsive individuals were categorised using the double median split method. 35 participants were labelled as ‘Accurate’ and 35 as ‘Inaccurate’, scoring above or below a median of 25.5 responses over 12 trials. 35 participants were labelled ‘Slow’ and 35 as ‘Fast’, responding above and below the median latency of 17905.50 milliseconds per trial.

25 participants were both slow and accurate which characterised a reflective style and 25 participants were fast and inaccurate which characterised an impulsive style.

**Table 8.1: Classification of reflective - impulsive style**

Labels	N	Latency to first response (ms)			Total no. of responses		
		Median	Min	Max	Median	Min	Maxi
<b>Reflective</b>	25	242754	17934	54587	20	13	25
<b>Impulsive</b>	25	11733	5815	17877	35	27	48
<b>Slow</b>	10	24014	19223	28847	33	26	40
<b>Fast</b>	10	12809	9645	17166	22	15	25

There was no significant difference in mean age between the groups ( $F(3, 66) = .798$ ,  $p = .500$ ) and no significant difference in sex ( $\chi^2 = 2.857$ ,  $df = 3$ ,  $p = .414$ )

## 8.4 Discussion

Accuracy and latency scores produced a satisfactory spread of scores which were approximately normally distributed. The correlation between latency and accuracy scores was  $-0.49$  indicating that longer reflection times were associated with greater accuracy. The correlation was moderate and consistent with the adult norms produced by Salkind (1977), which were reported as  $-0.41$  for males,  $-0.48$  for females and  $-0.43$  for the total sample, norms were based on 226 adults across 10 studies.

Internal consistency in the form of inter item consistency and split half reliability was high for latencies  $r = 0.91$  and  $r = 0.83$ ; but only moderate for errors,  $r = 0.56$  and  $r = 0.47$ . The moderate consistency for errors is in keeping with the normative data and has been the subject of criticisms, which have led the MFFT to be considered unreliable. However, the differing difficulty level of the stimuli would be expected to produce varying accuracy and when the latency and accuracy data are standardised and combined into a reflective-impulsive scale, the split half reliability of the scale is high,  $r = 0.74$ .

The MFFT has demonstrated satisfactory psychometric properties, which have been consistent with the available normative data. Whilst there has been criticism of the measure as lacking internal consistency and being sensitive to local processing style, it is more suitable than the MFFT-20 when used with adults.

**Section III.**

**Examining the Validity and Reliability  
of the  
Wholist-Analytic Dimension**

**Chapter 9:**

**Testing the Validity**

**of the**

**Wholist-Analytic Ratio**

## **Chapter 9: Testing the Validity of the Wholist-analytic Ratio**

### **9.1 Chapter Introduction**

The rationale outlined in Chapter four will be addressed in this chapter by testing a series of hypotheses, which collectively address the validity of the wholist-analytic ratio. The wholist-analytic ratio purports to measure differences in part and whole processing styles, but the central thesis here has argued that the wholist-analytic ratio is confounded by order effects which makes it sensitive to individual differences in reflective-impulsive style and it creates an asymmetry in the nature of processing being measured which confounds measures of style with comparisons of strategy efficacy. There are six hypotheses; the first three hypotheses stated in 10.1.1, 10.1.2 and 10.1.3 address the influence of reflective style and the other three hypotheses, stated in 10.1.4, 10.1.5 and 10.1.6 address the asymmetry in processing styles.

#### **9.1.1 Mean wholist-analytic ratios will be significantly higher in the WAS-WA than the WAS-AW.**

The lack of counterbalancing of the matching figure and embedded figure subtests in the CSA and in modified forms of the CSA such as the CSA-A and the CSA-B (Peterson et al, 2003) and the WAS Analysis will lead to the wholist-analytic ratio being confounded by order effects. This will be demonstrated using the WAS-WA and the WAS-AW; the WAS-WA presents the matching figure subtest first followed by the embedded figure subtest, thus preserving the presentation order of the CSA; the WAS-AW reverses the order of the subtests presenting the embedded figures subtest first followed by the matching figures subtest. The order effects will create longer latencies during early test items; this will inflate the wholist-analytic ratio when the matching figures subtest is presented first and depress the ratio when the

embedded figures subtest is presented first. Therefore the WAS-WA mean ratio is predicted to be higher than the WAS-AW mean ratio.

### 9.1.2 Reflective individuals will produce significantly higher ratios than impulsive individuals when responding to the WAS-WA

Reflective individuals are characterised by a tendency to be cautious in novel and uncertain situations, their tendency to reflect over alternate courses of action is based on a desire to be accurate. Reflective participants will be slower than impulsive individuals when approaching early test items and their reflective behaviour will diminish as their uncertainty diminishes.

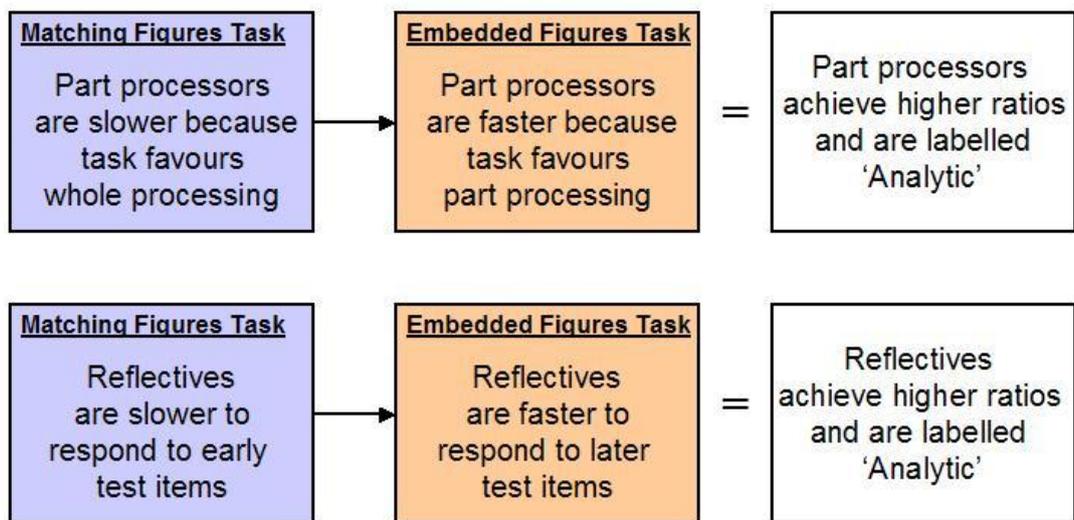


Figure 9.1: Complimentary order effects on part processing styles and reflective styles

Therefore, when the matching figure subtest is presented first (e.g. in the CSA, CSA-A, CSA-B and the WAS-WA) reflective individuals will produce higher, more analytic, ratios than the impulsive individuals.

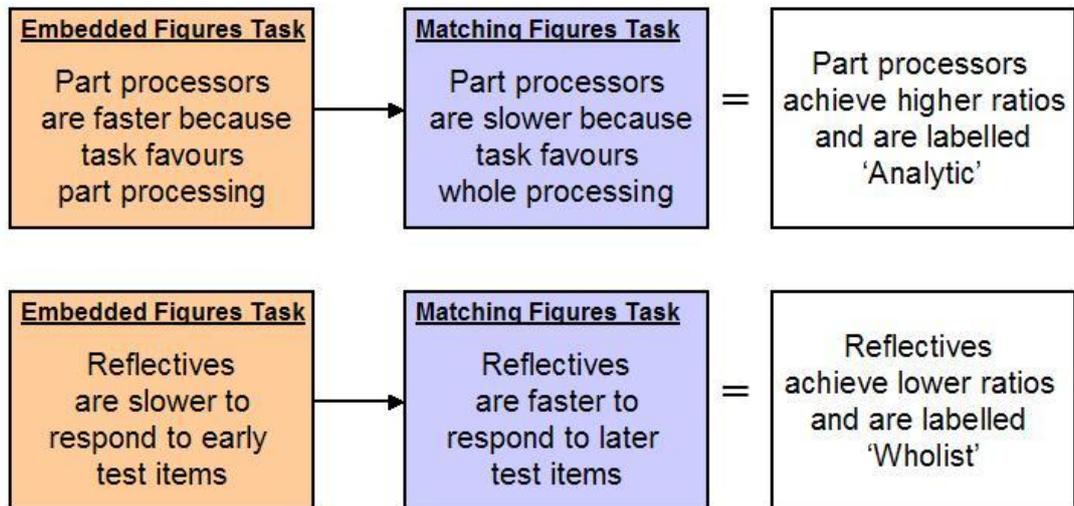
The construct validity of the wholist-analytic dimension predicts that analytic participants, who are characterised as such because of their preference for part processing, will also have a reflective style. This is because reflective-impulsive style is a member of the wholist-analytic ‘family’ and is integrated within the super-ordinate wholist-analytic dimension (Riding and Cheema, 1991).

In the context of the CSA, the CSA-A, the CSA-B and the WAS-WA, which present the matching figures subtest first, this means that reflective and part processing styles complement each other leading to inflated analytic order ratios, see Figure 9.1. Part processors will have longer response latencies to matching figure items compared to the embedded figure items because matching figure items are less suited to a part processing approach. Reflective individuals will also have longer response latencies to matching figure items compared to the embedded figure items because matching figure items occur earlier in the test and reflectives are slower to respond to early test items.

### **9.1.3 Reflective individuals will not produce significantly higher ratios than impulsive individuals when responding to the WAS-AW**

In the context of the WAS-AW the order effects will work in competing directions for part-whole processing styles and reflective-impulsive styles. Part processors will have longer response latencies to matching figure items compared to the embedded figure items because matching figure items are less suited to a part processing approach. However, reflective individuals will have longer response latencies to embedded figure items compared to the matching figure items because embedded

figure items occur earlier in the test and reflectives are slower to respond to early test items, see Figure 9.2.



**Figure 9.2: Competing order effects on part processing styles and reflective styles**

It follows that when the presentation order of the subtests are reversed, as they are in the WAS-AW, the tendency to be quicker at part processing tasks will be cancelled out by a concomitant reflective tendency to be slower in the first subtest.

#### **9.1.4 Analytics will have significantly lower three-part to five-part matching figure ratios (part-whole ratios) than wholists**

In Chapter four, it was argued that a processing asymmetry exists in the nature of processing being compared, between part and whole processors, to produce the wholist-analytic ratio. The embedded figures task can only be approached using part processing but the matching figures task can be approached using part processing or whole processing.

Since individuals are expected to use their preferred style of processing where possible, part processors will employ the same strategy for both tasks whereas whole processors will employ whole processing for the matching figures task but will be forced to use part processing for the embedded figures task. Therefore, for part processors, the wholist-analytic ratio compares the efficiency of part processing strategies across tasks whereas; for whole processors, the ratio compares their relative ability to use part or whole processing.

To test the hypothesis that an asymmetry exists, the number of simple shapes within the complex geometric figures in the trial items have been manipulated. The aim was to slow down the part processors relative to the whole processors by increasing the number of parts that need to be processed from three-parts to five-parts in half of the trial items. The differential speed of processing the three-parts to five-part items has been expressed as a ratio to control for individual differences in overall processing speed. The three-part to five-part ratio derived from the matching figures task is termed the 'matching figures ratio' (MFT ratio) or part-whole ratio'.

Individuals producing lower ratios have been slowed down relatively more, by the increase in constituent parts, than those producing higher ratios, suggesting the use of part processing rather than whole processing.

Support for the hypothesis “Analytics will have a significantly lower three-part to five-part matching figure ratio (part-whole ratio) than wholists” would suggest that analytic individuals were part processing the matching figure items whereas wholists were whole processing the matching figure items.

**9.1.5 There will be no significant difference between wholist and analytic individuals on their three-part to five-part embedded figure ratios**

The construct validity of the part-whole ratio derived from the matching figure items predicts that there should be no significant difference between analytics and wholists on the three-part to five-part ratio computed from the embedded figure items. This is because the wholists and the analytics should both have employed part processing to complete the embedded figure items. The fact that the wholists would be expected to be slower at part processing is irrelevant because the ratio calculation computes relative speed not overall speed. The ratio derived from the three-part to five-part embedded figures tasks is termed the embedded figures ratio (EFT ratio)

**9.1.6 The increase complexity of the five part figures will lead to longer response latencies irrespective of wholist-analytic style; therefore, processing times for five-part figures should be greater than for three-part figures.**

Finally, the increased complexity of the five part figures is likely to make the trials more difficult and naturally increase response latencies; whilst the degree of this increase has been hypothesised to discriminate between part and whole processors, all participants are expected to produce ratios of less than one, indicating that they took longer to process five-part figures than three-part figures.

## 9.2 Method

### 9.2.1 Participants

193 first and second year psychology undergraduates completed the Wholist-Analytic Style (WAS) analysis. Participants were approached during their weekly research methods workshops and received course credit for participating. 5 participants produced results below the minimum accuracy requirement of 85%; these results were discarded leaving 188 participants. Of these, 102 completed the embedded figures section first, (WAS-AW) and 86 completed the matching figures section first, (WAS-WA). There was no significant difference between the age or sex of samples in each test condition ( $F(1, 187) = .143, p = .706$  and  $F(1, 187) = .019, p = .891$ , respectively), see Table 9.1 for a breakdown.

**Table 9.1: Participant age and sex**

Test condition	N	Sex	Mean Age	SD
WAS-AW	102	27M, 75F	21.92 yrs	6.23 yrs
WAS-WA	86	22M, 64F	22.27 yrs	6.27 yrs
<b>Total</b>	188	52M, 141F	22.08 yrs	6.23 yrs

### 9.2.2 Measurements

The WAS analysis is a computer presented, eighty-item test based on the wholist-analytic sections of the CSA. It was constructed and administered using E-prime 201

(Psychology Software Tools, Inc., Pittsburgh, PA). The test is in two sections, the matching figures section, which consists of forty matching figure items and the embedded figures section, which consists of forty embedded figure items. The matching figure tasks present a pair of complex figures, which require a yes/no response to indicate whether the two figures are the same. The embedded figure tasks present a simple shape and a complex geometric figure, which also require a yes/no response to indicate whether the simple shape is contained within the complex figure. Respondents are required to complete four example items prior to each subtest.

Two versions of the WAS analysis were used; the WAS-WA presents the matching figures subtest first followed by the embedded figures subtest which preserves the order in which subtests are presented in the CSA. The WAS-AW reverses the order, presenting the embedded figures subtest first.

‘Yes’ and ‘No’ comparisons were counterbalanced within each section and all items were presented randomly without replacement. Half of the complex figures in each section were constructed using three constituent parts, and half were constructed using five constituent parts. A summary of the counterbalancing methods used in the WAS analysis are tabulated below in Table 9.2.

**Table 9.2: Breakdown of counterbalancing measures**

Subtest	Number of Trials	Number of 3 or 5 part figures		Number of yes/no responses required	
				Yes	No
Matching Figures	40	3 part	20	Yes	10
				No	10
		5 part	20	Yes	10
				No	10
Embedded Figures	40	3 part	20	Yes	10
				No	10
		5 part	20	Yes	10
				No	10
<b>WAS Analysis</b>	<b>80</b>				

**9.2.3 Data Analysis*****Wholist-Analytic Style Calculation***

The wholist-analytic ratio was calculated by dividing the median response latency to items in the matching figures section by the median response latency to items in the embedded figures section. A ratio of below one indicates that an individual responded relatively faster to the matching figure items, and a ratio of above one indicates that an individual responded relatively faster to the embedded figure items

### ***Reflective–Impulsive Style Calculation***

Median latency for all WAS analysis trials and the number of errors was categorised as either high or low using the median split method for each variable.

Those with median latencies greater than 1602.25 milliseconds and a total number of errors of 3 or less were categorised as reflective (N=67); those in the high speed and the low accuracy groups were labelled ‘impulsive’ (N=56), the remaining participants were labelled ‘fast’ if they had both high speed and high accuracy or ‘slow’ if they had low speed with low accuracy (N = 35 and 30, respectively). A sample breakdown of summary statistics is provided in Table 9.3.

**Table 9.3: Summary sample statistics by reflective-impulsive style classification**

Classification labels	N	Sex		Age (years)	
		M	F	Mean	SD
<b>Reflective</b>	64	20	44	22.39	6.43
<b>Impulsive</b>	59	14	45	20.98	4.78
<b>Fast</b>	40	10	30	20.88	4.17
<b>Slow</b>	35	9	26	24.71	8.94

There was no significant difference in sex across groups ( $\chi^2 = 1.017$ ,  $p = .797$ ) but there was a significant difference in age ( $F(3, 193) = 3.321$ ,  $p = .021$ ). Tukey HSD post hoc tests revealed that there was no significant difference in age between the reflective, fast and impulsive groups, but the slow group were significantly older than the impulsive participants ( $p = 0.30$ ).

By definition the completion times for reflective and slow groups were significantly longer than the impulsive and fast groups ( $F_{3,184} = 74.070$ ,  $p < .0001$ ) but Tukey HSD comparisons revealed no significant differences in completion test times between the fast and the impulsive ( $p = .632$ ) and between the slow and the reflective ( $p = .731$ ).

All differences between groups in mean accuracy were significant ( $F_{3,187} = 140.232$ ,  $p < .0001$ ); naturally the reflective and fast groups should be more accurate than the slow and impulsive by the nature of the classification but in addition to that post hoc comparisons showed that the reflective are significantly more accurate than the fast ( $p = .037$ ) and the slow are significantly more accurate than the impulsive ( $p = .004$ ), indicating, perhaps unsurprisingly that time is a factor in accuracy.

### **9.3 Results**

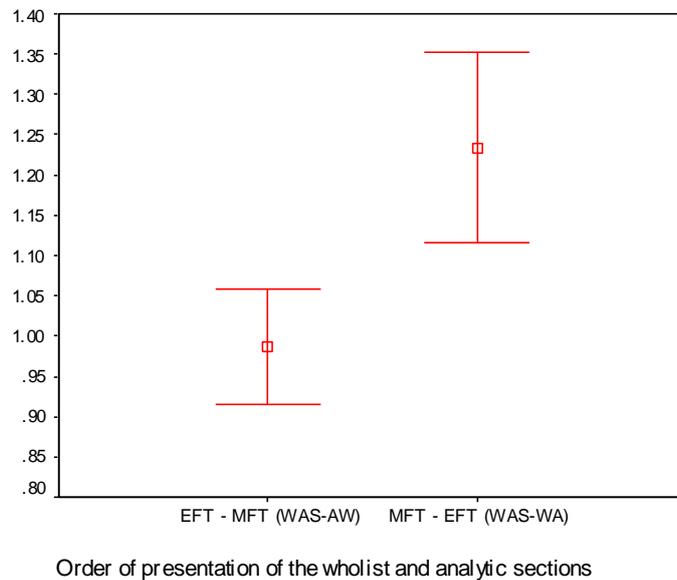
#### **9.3.1 Mean wholist-analytic ratios will be significantly higher in the WAS-WA than the WAS-AW.**

To address the first hypothesis wholist-analytic ratios were calculated for each test version and are summarised in Table 9.4.

**Table 9.4: Mean and spread of wholist-analytic ratios produced by test version**

Test Condition	Mean Ratio	Standard Deviation	Standard Error Mean	Kolmogorov-Smirnov Z
WAS-AW	0.99	0.22	0.02	Z = 1.084, P = 0.19
WAS-WA	1.23	0.32	0.03	Z = 0.951, P = 0.33

A t-test revealed that the mean ratio was significantly lower for participants presented with the embedded-figures section first than for participants presented with the matching figures section first, means of 0.99 and 1.23 respectively ( $t = 6.117$ ,  $df = 186$ ,  $p < 0.001$ ). The mean difference represents a large effect size of ( $d = 0.92$ ) and there is no overlap between the error bars based at 99.9% confidence intervals, (Figure 9.3).



**Figure 9.3: 99.9% Confidence limits and means for the wholist-analytic ratio by test version**

The hypothesis was supported; when the embedded figures section was presented first, lower ratios were produced, with an expected population mean of between 0.92 and 1.06. When the matching figures section was presented first, higher ratios were produced, with an expected population mean of between 1.12 and 1.35.

Participant scores were further analysed to illustrate the effect of subtest presentation order on wholist-analytic classifications. The lowest 30%, mid 40% and highest 30% of ratios obtained in the WAS-AW and the WAS-WA were labelled as wholist, intermediate and analytic, respectively. The ratio cut-off points are illustrated in Table 9.5. Riding's (1991) guidelines for classification are provided for comparison.

**Table 9.5: Classification of wholist-analytic style ratio**

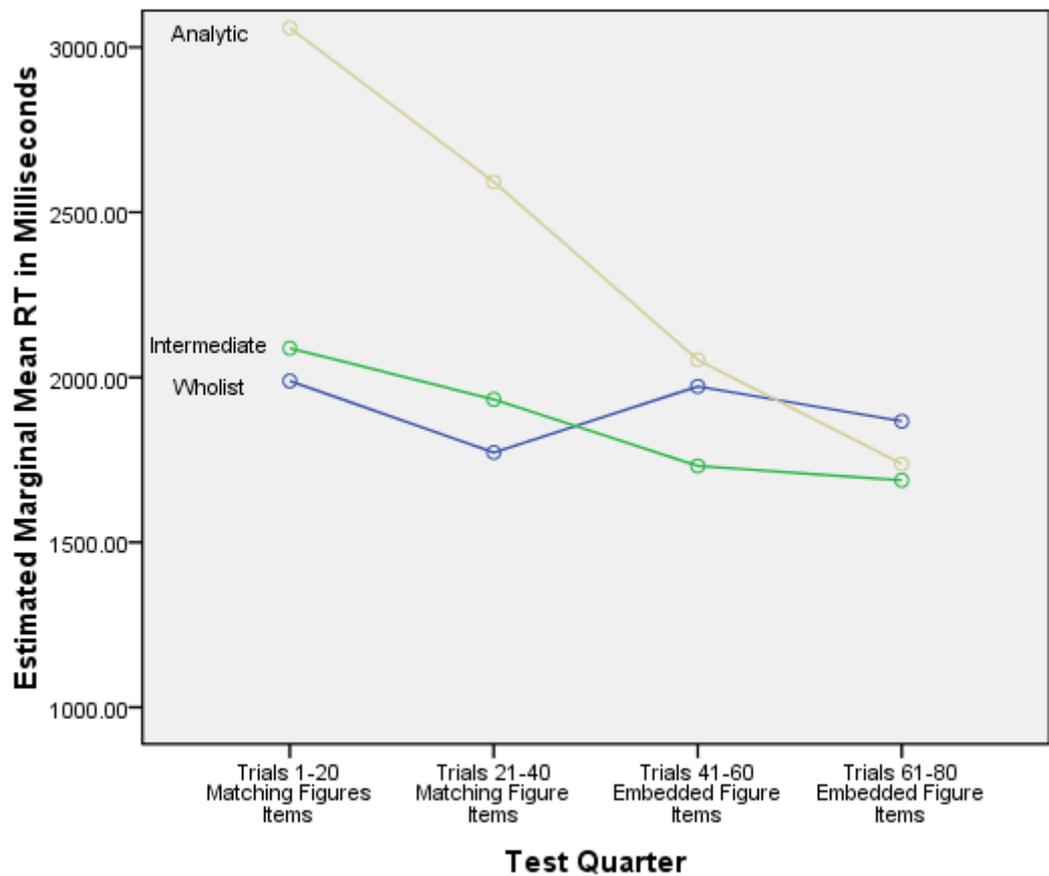
Classification labels	WAS-AW		WAS-WA		CSA Guidelines
	N	Ratio	N	Ratio	Ratio
<b>Wholist</b>	35	$\leq 0.88$	28	$\leq 1.05$	$\leq 1.02$
<b>Intermediate</b>	40	$> 0.88 < 1.05$	33	$> 1.05 < 1.33$	$> 1.02 < 1.36$
<b>Analytic</b>	32	$\geq 1.05$	25	$\geq 1.33$	$\geq 1.36$

*The basis of the difference in ratios between the WAS-WA and WAS\_AW*

67.8% of the total sample had slower median reaction times to items in the first subtest than in the second subtest. This has the effect of lowering the ratio when embedded figures items are presented first and inflating the ratio when matching figures items are presented first.

It appears that the speed at which participants approach the first subtest effectively discriminates between wholist-analytic ratios but the speed at which participants complete the second subtest does not, see Figures 9.4 and 9.5.

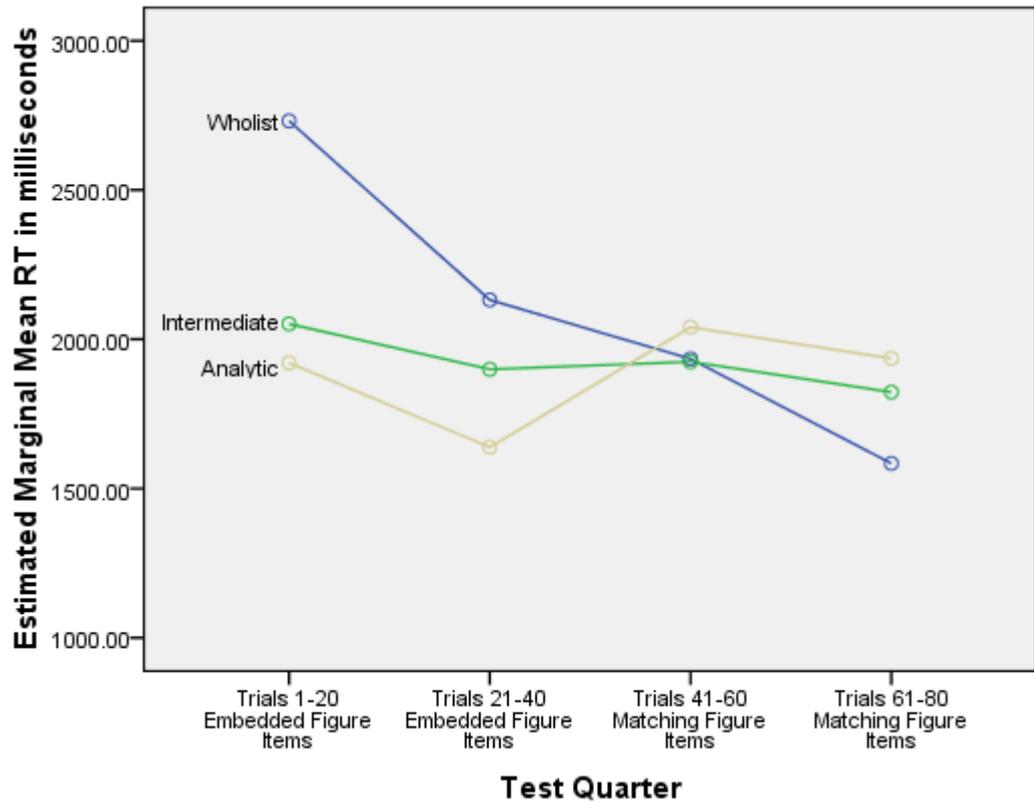
A multivariate ANOVA was performed on the WAS-WA response latencies; wholist-analytic style was the between subjects factor with three levels, wholist, intermediate and analytic; test quarter was the within subjects factor with four levels, first, second, third and fourth quarter. There was a significant effect of style ( $F 2, 90 = 4.397, p = .016$ ), Bonferroni post hoc tests revealed that analytics had longer latencies than wholists ( $p = 0.47$ ). There was a significant effect of test quarter ( $F 3, 270 = 57.569, p < .001$ ) with latencies decreasing from the first to the last quarter. Most interestingly there was a significant interaction between style and test quarter ( $F 6, 270 = 24.325, p < .001$ ). Post hoc tests revealed that analytics were significantly slower than wholists in the first ( $F 2, 90 = 11.333, p < .001$ ) and second quarters ( $F 2, 90 = 8.711, p < .001$ ) but not in the third ( $F 2, 90 = 1.753, p = .179$ ) and fourth ( $F 2, 90 = 674, p = .512$ ) quarters, see Figure 9.4.



**Figure 9.4: WAS-WA mean latencies in each test quarter by wholist-analytic style**

The findings above replicated the results in Chapter seven regarding the discriminatory power of the subtests and raise the question of whether the discriminatory power is a feature of the matching familiar figures test or whether it is a result of reflective tendencies to early test items.

This question was addressed by performing a second multivariate ANOVA on the WAS-AW response latencies; again, wholist-analytic style was the between subjects factor with three levels, wholist, intermediate and analytic; test quarter was the within subjects factor with four levels, first, second, third and fourth quarter.



**Figure 9.5: WAS-WA mean latencies in each test quarter by wholist-analytic style**

There was no significant effect of style ( $F(2, 102) = .766, p = .467$ ). There was a significant effect of test quarter ( $F(3, 306) = 18.689, p < .001$ ) with latencies decreasing from the first to the second quarter and from the third to the fourth quarter. There was significant interaction between style and test quarter ( $F(6, 306) = 12.634, p < .001$ ). Post hoc tests revealed that analytics were significantly slower than wholists in the first ( $F(2, 104) = 4.118, p = .019$ ) and second quarters ( $F(2, 104) = 3.918, p = .023$ ), but not in the third ( $F(2, 104) = .318, p = .728$ ). The difference, in the fourth quarter, approached significance ( $F(2, 104) = 3.064, p = .051$ ) see Figure 9.4.

The discriminatory power of the WAS analysis lays in the first subtest, regardless of the type of task, either embedded or matching figure task. The WAS Analysis discriminates, amongst those who have a tendency to produce longer latencies to early test items. The presentation order of the matching figures and embedded figures subtests determines the style of the participants based on their cautious approach to early test items. In the WAS-WA individuals who are slower in the first subtest are labelled analytic; in the WAS-AW, the same people would be labelled wholist. Participants who have a tendency to approach early test items with caution are expected to do so because they have a reflective style. The question remains whether the WAS analyses discriminate entirely between reflective-impulsive characteristics or whether they are also sensitive to differences in part-whole processing. The following two hypotheses address this question.

### **9.3.2 Reflective individuals will produce significantly higher ratios than impulsive individuals when responding to the WAS-WA**

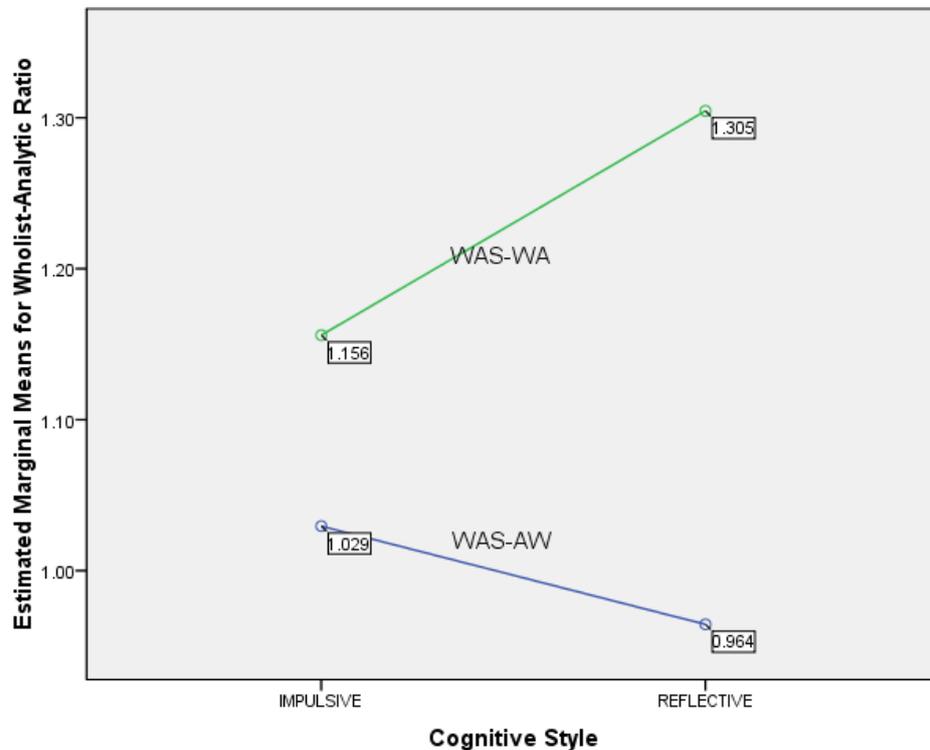
It was reasoned, in Chapter four, that the tendency of reflective participants to be slower in the first subtest of the WAS-WA would be amplified by concomitant analytic tendencies to be relatively slower at the matching figures tasks than the embedded figures tasks.

### **9.3.3 Reflective individuals will not produce significantly different ratios than the impulsive individuals when responding to the WAS-AW**

It was also reasoned that the tendency of reflective individuals to be slower in the first subtest of the WAS-AW than in the second would be nullified by concomitant analytic tendencies to be relatively slower at the matching figures tasks than the embedded figures tasks.

The findings revealed a greater proportion of the reflective individuals responded more slowly to items in the first half of the test, 77.6% of reflective individuals compared to 63.9%, 60% and 63.3% for the impulsive, fast and slow groups, respectively, providing initial support for the hypotheses.

A univariate analysis of variance examined the effect of presentation order (WAS-WA versus WAS-AW) and reflective-impulsive style (reflective versus impulsive) on the wholist-analytic ratio. The results revealed significant interaction between reflective-impulsive style and the presentation order of the wholist-analytic sections ( $F_{1, 118} = 5.96, p = .016$ ) see Figure 9.6.



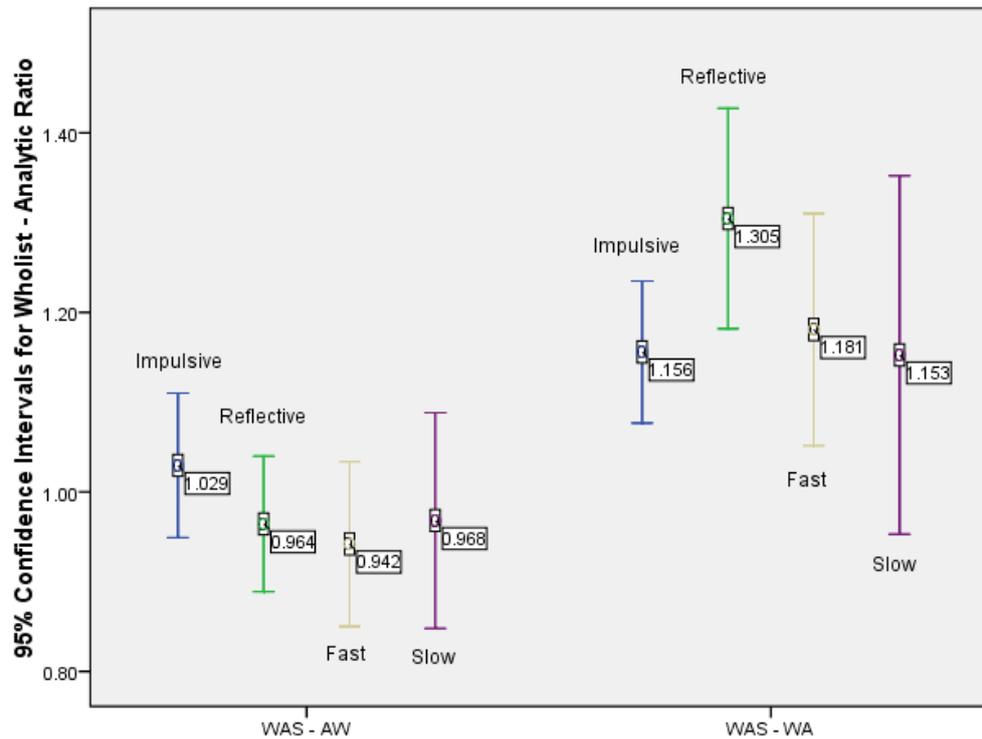
**Figure 9.6: Wholist-Analytic ratios produced by reflective and impulsive individuals when order of presentation of wholist-analytic sections is manipulated**

Two post hoc t-tests revealed that, when the matching figure items were presented first, in the WAS-WA, reflective individuals produced significantly more analytic ratios than the impulsive individuals (ratios of 1.31 and 1.16, respectively,  $t = 2.138$ ,  $df = 56$ ,  $p = .018$ ,  $d = 0.56$ ). Therefore, reflective individuals did produce significantly higher ratios than impulsive individuals when responding to the WAS-WA.

When the analytic items were presented first in the WAS-AW condition, reflective individuals produced more wholist ratios than the impulsive individuals but this difference was not significant (ratios of 0.96 and 1.03, respectively,  $t = 1.204$ ,  $df = 59.95$ , equal variances not assumed,  $p = 0.233$ ,  $d = 0.30$ ). This supports the hypothesis that predicted no significant difference between the ratios of reflective and impulsive individuals.

The results suggest that the wholist-analytic ratio is indeed very sensitive to the influence of reflective-impulsive style; this casts doubt on the construct validity of the wholist-analytic dimension. However, the results also suggest that the wholist-analytic ratio is subject to complimentary and conflicting effects of concomitant differences in reflective-impulsive style and wholist-analytic style that are dependent on the presentation order of the subtests. This provides support for the construct validity of the wholist-analytic dimension despite casting doubt on the method used to measure it.

The evidence provided so far supports the prediction that participants generally tend to appear more wholist when the embedded figures subtest is presented first and more analytic when the matching figures subtest is presented first because people have a tendency to react more slowly to early test items; and that this tendency is greater for individuals with a characteristic reflective style. This is summarised clearly by the 95% confidence intervals illustrated in Figure 9.7



**Figure 9.7: 95% Confidence Intervals of Wholist-Analytic ratios produced by reflective and impulsive individuals by order of subtest presentation**

The remaining hypotheses addressed a postulated asymmetry in the wholist-analytic ratio. Chapter four argued that where possible individuals will use their preferred processing style; it was also argued that the matching figure items allow a choice of wholist or part processing style whilst the embedded figure task constrains the respondent to employ part processing. This sets up an asymmetry in which part processors employ part processing for both tasks and are labelled as analytic because part processing is more suited to embedded figures tasks than matching figures tasks. However, whole processors use whole processing for the matching figures tasks but are forced to use part processing on the embedded figures tasks and are labelled wholists because they are more proficient when employing a whole processing strategy.

In order to explore this asymmetry the number of constituent shapes in the complex geometric figures was varied from three to five; part processing five-part figures should take proportionately longer than part processing three-part figures but whole processing five-part figures should not take proportionately longer than whole processing three-part figures. Therefore those that took proportionately longer to process five-part matching figure items in comparison to three-part matching figure items must have employed part processing but those who did not take proportionately longer must have employed whole processing.

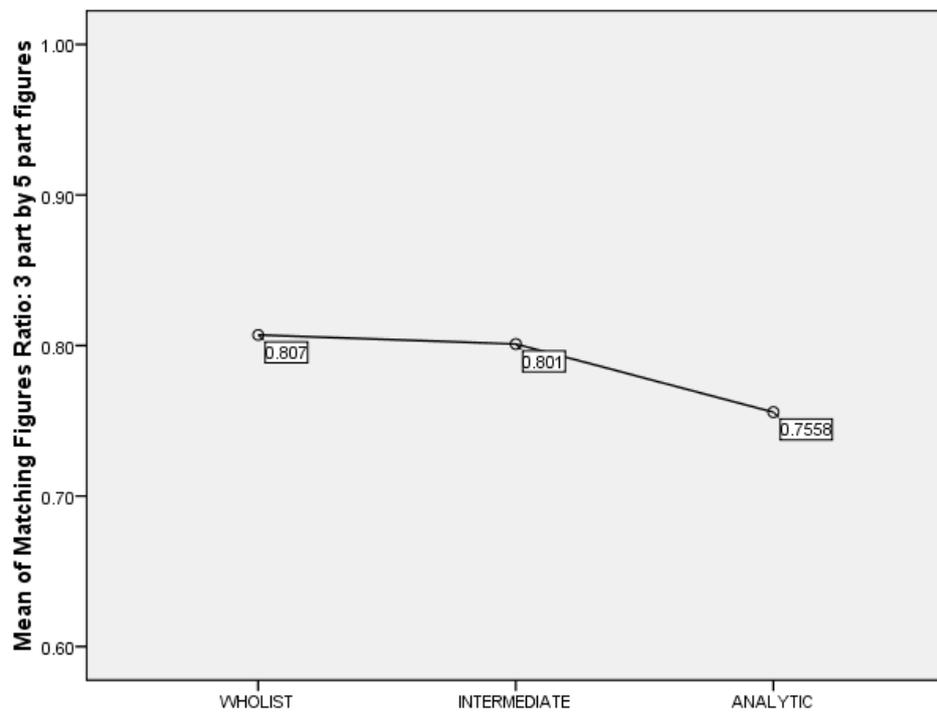
The matching figure five to three part ratio or ‘part-whole ratio’ was calculated based on the ratio of the median reaction time to three-part compared to five-part matching figure items. Lower ratios indicate proportionately larger increases in speed of processing five-parts to three-part figures and which will provide indirect evidence of part processing.

#### **9.3.4 The Part-Whole ratio will be significantly lower for analytic individuals than wholist individuals**

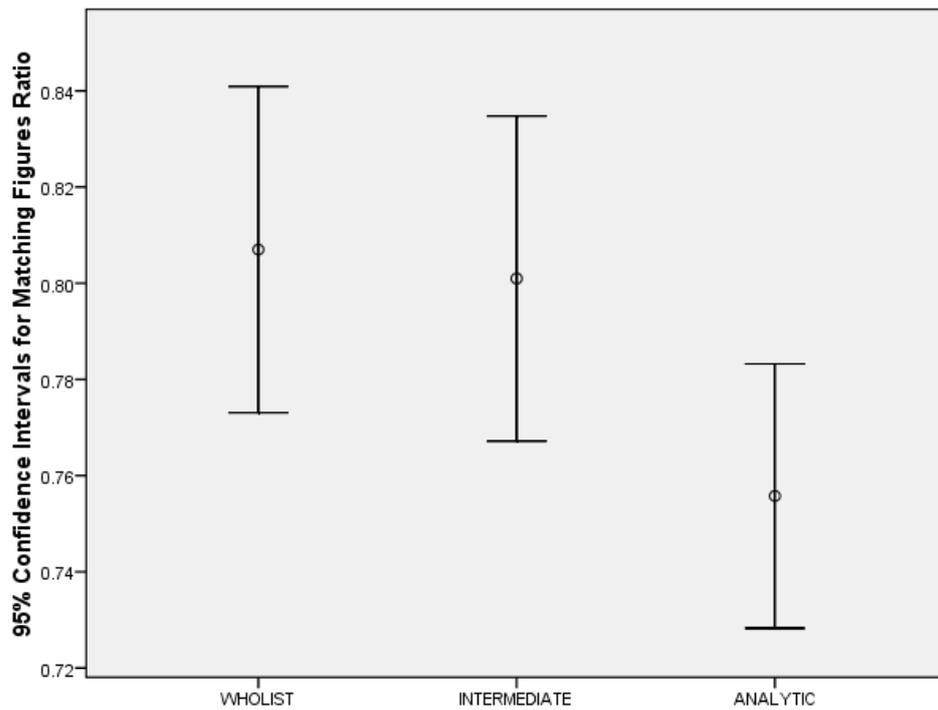
A one-way ANOVA was employed to examine the effect of wholist-analytic style on the part-whole ratio and there was a significant effect of wholist-analytic style on the part-whole ratio ( $F_{2, 195} = 3.118, p = .046$ ). Wholist, intermediate and analytic group means were 0.81, 0.80 and 0.76, respectively, see Figure 9.8.

To give a clearer picture of the effect illustrated in Figure 9.8, the scale used begins at .60 which represents an individual whose processing time increased consistently with the number of parts in the figure, for example if it took 6 seconds to disembed the simple shape from a complex figure made up of 3 parts then it would take 10 seconds to perform the same task on a complex figure consisting of 5 parts. At the

other end of the scale, a ratio of one means that the same time was taken to process the five-part figures and the three-part figures.



**Figure 9.8: Mean part-whole ratios by wholist-analytic style**



**Figure 9.9: 95% confidence intervals for mean part-whole ratios by wholist-analytic style**

Post hoc tests revealed that analytics had lower ratios than wholists and this difference approached significance ( $p = .070$ ) suggesting that the processing of 5 part figures slowed their processing speeds more than it did for the wholists, with a moderate effect size of  $d = .41$

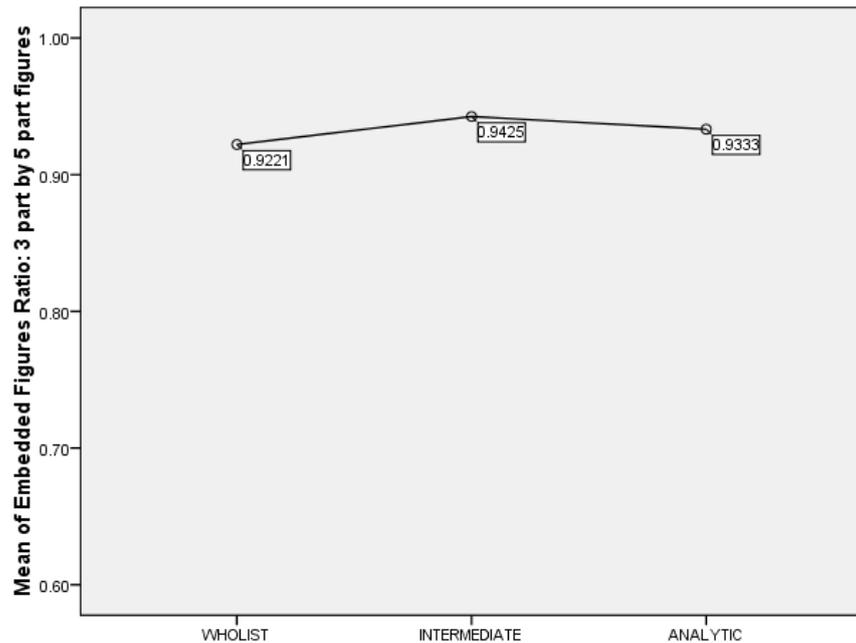
Based on 95% confidence intervals, the population means for wholists and intermediates would be expected to be between .77 and .84, respectively, suggesting that it would take them between 17.5% and 29% longer, respectively, to process 5 part figures than 3 part figures. Analytics would be expected to take on average 28% - 38% longer to complete the 5 part figure tasks than the 3 part figures, see figure 9.9

The construct validity of the part-whole ratio relies on the fact that there should not be a similar ratio difference between wholists and analytics on the ratio derived from the embedded figures tasks. If the embedded figure ratio did discriminate between wholists and analytics in the same way as the part-whole ratio did then the difference could be attributed to the increased complexity which was introduced by the five-part figures. Therefore, a second ratio was calculated which reflected the median reaction time to three-part compared to five-part embedded figure items.

### **9.3.5 There will be no significant difference between the embedded figure ratios of wholist and analytic individuals**

A second one-way ANOVA was performed to examine the effect of wholist-analytic style on the embedded figures ratio. There was no significant effect of cognitive style on the embedded figures ratio ( $F(2, 195) = 0.455, p = 0.635$ ); this supports the notion that all participants are using part processing to complete the embedded figures items and is evidence for the construct validity of the part-whole ratio.

The mean embedded figure ratios, for wholist, intermediate and analytic groups, were .92, .94 and .93 respectively, see Figure 9.10. The mean ratios produced by all groups were between .92 and .94, which suggests that it took them approximately the same time to disembed from a three-part figure as it did from a five-part figure. For example, a ratio of .93 shows that if it takes 6 seconds to disembed from a three-part figure, it only takes 6.45 seconds to perform the same task on the five-part figure.



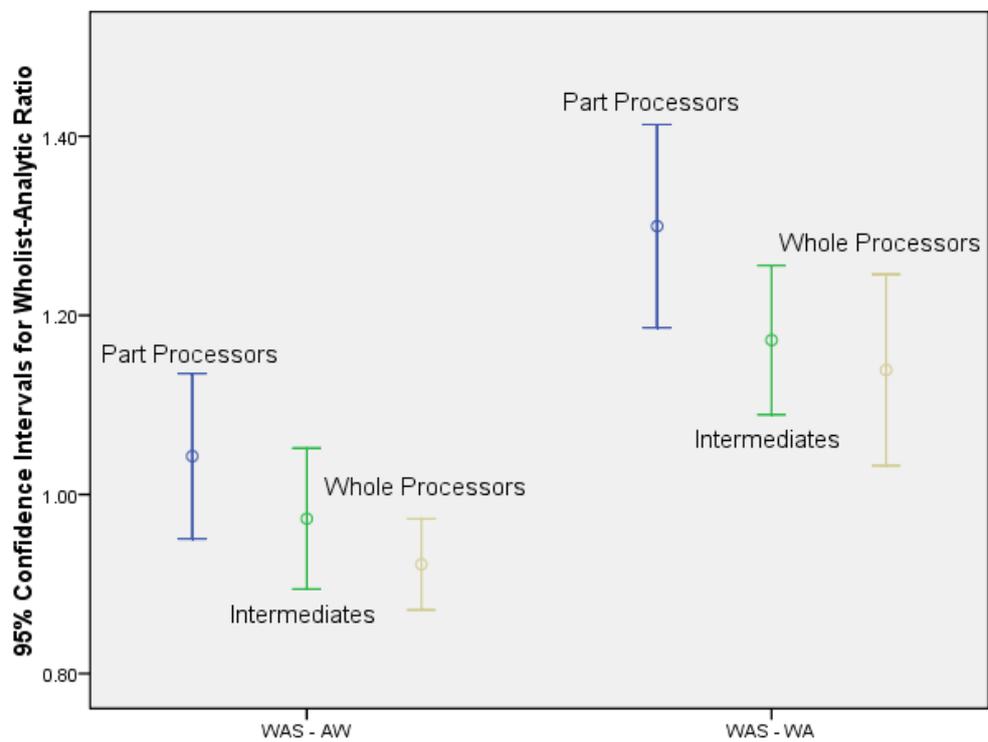
**Figure 9.10: Mean embedded figure ratios by wholist-analytic style**

There does appear to be an asymmetry in the processing being used by wholists and analytics suggesting that analytics are using part processing and wholists are using whole processing. To explore this further three groups were created by making two equal cut points in the matching figure ratios; those producing the lowest ratios were labelled ‘Part processors’, those in the intermediate groups were labelled ‘Intermediates’, and those producing the highest ratios were labelled ‘Whole processors’, see sample statistics in Table 9.6. There was no significant difference in age ( $F_{2, 194} = 1.860, p = .158$ ) or sex ( $X^2 = 2.425, p = .298$ ) between the groups.

Given the influence of subtest presentation order on the wholist-analytic ratio it is important to establish that the part-whole style ratio is not sensitive to the same confounds. Based on 95% confidence intervals the figure below shows the effect of Part-Whole processing style on the Wholist-Analytic ratio for both versions of the WAS Analysis.

**Table 9.6: Age and summary part-whole ratio statistics**

Processing Style	Mean Age	Matching Figures Ratio Statistics			
		Mean	Min.	Max.	Std. Dev
Part Processors	23.11	.65	.47	.71	.06
Intermediates	22.12	.78	.71	.84	.04
Whole processors	21.02	.93	.85	1.12	.07



**Figure 9.11: 95% confidence intervals for mean wholist-analytic ratios by part-whole processing style**

Figure 9.11 shows that part processors are the most analytic, followed by the intermediates and then the Whole processors. As is to be expected, all the groups produced higher ratios in the WAS-WA but more importantly the pattern of results remains consistent across the versions suggesting that it is not influenced by the confounds of reflective-impulsive style.

Using the part-whole processing ratio, the notion that part processors are reflective and whole processors are impulsive was explored. A chi-squared test showed a significant association between the part processors and the reflective individuals and the whole processors and the impulsive individuals ( $X^2 = 20.164$ ,  $p < .001$ ), see the cross tabulated data in Table 9.7 (expected count in brackets).

**Table 9.7: Frequency of reflective-part processors and impulsive-whole processors**

<b>Style Groups</b>	<b>Part Processors</b>	<b>Intermediates</b>	<b>Whole Processors</b>	<b>Total</b>
<b>Impulsive</b>	9 (20.1)	22 (19.7)	28 (19.2)	59
<b>Reflective</b>	33 (21.9)	19 (21.3)	12 (20.8)	64
<b>Total</b>	42	41	40	123

There were 34% more reflective, part processors than expected by chance and 42% fewer reflective, whole processors than would be expected. Similarly, there were 55% fewer impulsive, part processors than would be expected and 46% more impulsive, whole processors than would be expected.

A t-test echoed these results showing that reflective participants had significantly lower part-whole ratios than impulsive participants ( $t = 4.471$ ,  $p < .0001$ ,  $df = 121$ , means of .74 and .84, respectively).

In order to emphasise the validity of these findings, there is no similar difference between reflective and impulsive individuals on their embedded figure ratios, both groups produced mean ratios of .95 ( $t = .239$ ,  $p = .406$ ,  $df = 120.96$ , equal variances not assumed) and no association between reflective-impulsive individuals and those producing high, intermediate and low embedded figures ratios ( $X^2 = 2.351$ ,  $p = .309$ ). This supports the notion that the link between reflective-impulsive individuals and their part-whole processing styles are based on part whole differences and not merely an artefact of increasing the complexity of the figures by including more constituent parts.

The final hypothesis addressed the increased complexity introduced by the manipulation of three and five-part geometric figures.

**9.3.6 All participants will produce longer latencies to the five-part figures because of the increase complexity of the 5 part figures; therefore, processing times for 5 part figures should be greater than for 3 part figures irrespective of cognitive style.**

There is of course likely to be some increase in response latency as a result of processing the more complex five-part figures than the less complex three-part figures but this increase is predicted to effect all participants and would not be limited to a particular style.

A series of paired t-tests confirmed that wholist, intermediate and analytic participants; reflective, impulsive, slow and fast participants; and part processors, intermediate processors and whole processors all had significantly longer mean latencies to trials involving five-part figures than three-part figures ( $p < .001$  for all tests, Bonferroni corrected,  $p < .05$  corrected to  $p < .005$ ).

## **9.4 Discussion**

The wholist-analytic ratio is extremely sensitive to the order in which the matching figure and embedded figure subtests are presented. There is a general tendency for respondents to produce slower median reaction times in the first subtest and faster times in the second subtest. This has the effect of increasing the wholist-analytic ratio when the matching figures section is presented first and decreasing the ratio when the embedded figures section is presented first. The implication of this finding is that since the CSA always presents the matching figure subtest first, respondents will produce inflated ratios and therefore appear more analytic. This explains Riding's consistent finding that the population as a whole is skewed toward being more analytic and the mean ratio is 1.25 (Riding, 1998; 2005)

### **9.4.1 The influence of reflective-impulsive style on the wholist-analytic ratio**

More interesting, however, is the systematic difference, which emerged between individuals characterised as having a reflective or impulsive style.

Reflective individuals were identified by their relatively slower median response latencies and their greater accuracy. The tendency to produce slower median reaction times to the first subtest was greater amongst the reflective group and resulted in reflective individuals appearing more analytic when the matching figures section was presented first. It is important to note, however, that when the embedded figures section was presented first there was no significant difference between the wholist-analytic ratios of reflective and impulsive individuals. The findings suggest that the wholist-analytic ratio is influenced by individual differences in reflective-impulsive approaches and part-whole processing style.

It appears that when the matching figures subtest is presented first, as in the WAS-WA version of the WAS analysis and in the CSA (Riding, 1991), the differences between analytic and wholist styles are amplified by concomitant differences in reflective-impulsive style, for example individuals with an analytic style and a concomitant reflective approach will be relatively faster in the second subtest by virtue of the order of presentation and the nature of the task. Conversely, when the embedded figures section is presented first, differences between analytic and wholist styles are cancelled out by the concomitant differences in reflective-impulsive style, for example, an analytic style would produce relatively faster responses to the first subtest by virtue of the nature of the task but a concomitant reflective approach would produce faster responses to the second subtest by virtue of the order of presentation.

It seems that the reliance on differential speed and the problems relating to the order of subtest presentation confounds the wholist-analytic ratio with the influence of reflective-impulsive style. When the wholist section is presented first, as it is in the CSA (Riding, 1991), the confounding influence inflates the wholist and analytic differences in a way, which is consistent with Ridings' theoretical assumption that part processors will have a reflective style and whole processors will have an impulsive style.

Two future approaches may adequately control for the influence of reflective style. The first is to use a measurement of wholist-analytic style, which does not involve processing speed or accuracy as the basis of the measurement. For instance, completion of embedded figures and matching figures tasks could be conducted whilst using apparatus, which would track eye movements. This would be a more direct measure of the tendency to use part or whole processing. The second option, and perhaps the most practical alternative, would be to adapt the existing measurement, employing counterbalancing methods in a similar fashion to those

used for the verbaliser-imager dimension of the CSA. Rather than presenting matching figure items and embedded figure items in different subsections, the two task types could be randomly presented within the same section. In this way a tendency to produce slower processing speeds at the beginning of the test would affect the speed of processing matching figure items and embedded figure items alike.

These results question the validity of the wholist-analytic dimension measure of the wholist-analytic dimension, providing evidence that the present methodology of the CSA renders the wholist-analytic ratio very sensitive to the influence of reflective-impulsive style and to order effects. However, the research does provide some support for Riding's theoretical assumption that analytic-wholist style is likely to correlate with similar constructs, i.e. reflective-impulsive style, thus providing support for the validity of the wholist-analytic construct if not the measure.

#### **9.4.2 A processing asymmetry in the wholist-analytic ratio**

The manipulation of the number of constituent parts in the embedded figures stimuli was intended to assess whether there was an asymmetry in the nature of the processing used by respondents. It was suggested that if there was no significant difference in the extent to which the more complex figures reduced the processing speed of wholists and analytics, then the wholist-analytic ratio would appear to be based on the individual's capacity to whole process matching figure items and part process embedded figures items. However, if the increase in constituent parts of the matching figure items slowed down the analytic individuals more than the wholist individuals then this would suggest that the analytic individuals were part processing the matching figure items whilst wholists were whole processing these items. No difference was expected between the degrees to which analytics were slowed down

on the embedded figure items compared to the wholists because the embedded figures test is assumed to necessitate part processing.

As predicted there was no significant effect of wholist-analytic style on the embedded figures ratio suggesting that all participants were using part processing to complete the embedded figures tasks. There was, however a significant effect of wholist-analytic style on the matching figures ratio; the increase in the numbers of parts in the complex geometric figures slowed down the analytic participants significantly more than the wholists or intermediates suggesting that the wholists and intermediates used whole processing but the analytics used part processing to complete the matching figures tasks.

There does, therefore, appear to be an asymmetry in the nature of processing used by analytics and wholists, which reduces the validity of the wholist-analytic ratio. Wholists and intermediates use whole processing for the matching figures tasks and part processing for the embedded figures tasks. This is an ideal situation since their ratios are based on their ability to whole process against their ability to part process, which is the fundamental characteristic of wholist-analytic style. Where the problem lies is with the analytics; they use part processing for the matching figures and the embedded figures task and therefore their ratios are based on the relative efficacy of a part processing strategy across tasks. The solution would be to find a task to replace the matching figures trials that would force the analytics to use whole processing, but this is likely to be more difficult than it sounds.

Whilst the part-whole processing ratio has highlighted an asymmetry in the wholist-analytic ratio, it has also indirectly demonstrated that analytics and wholists do have a preferred processing style and that given the opportunity wholists will use whole processing and analytics will use part processing. This is the central premise of Riding's wholist-analytic dimension despite the fact that the existence of such a difference has not been demonstrated sufficiently in the literature. This provides

further support for the construct validity of the wholist-analytic dimension but again casts doubt on the wholist-analytic ratio calculation, as does the reported link between the part-whole ratio and reflective-impulsive style.

It was found that reflective individuals were more often than expected classified as part processors and impulsive individuals were more often classified as whole processors. Reflective individuals also had significantly lower part-whole ratios than wholists or intermediates suggesting that the reflective individuals are also part processors. This relationship is not an artefact of speed of processing because the ratio calculation prevents that and it is not an artefact of the increased complexity of the five-part figures because the effect was not seen with the embedded figures ratio.

The part-whole ratio discriminates between those who are part processing and those who are whole processing and is not confounded by order effects nor is it sensitive to reflective-impulsive style as the wholist-analytic ratio is, however, it does not offer a working alternative to the wholist-analytic ratio. The part-whole ratio was designed to expose an asymmetry and having done that the recommended action would be to eradicate that asymmetry thereby increasing the validity of the wholist-analytic ratio. The part-whole ratio only discriminates between analytics and wholists whilst the asymmetry exists; further, even if the asymmetry remains the part-whole ratio only measures one end of the dimension, a tendency to part or whole process analytic items. The part-whole ratio is a research tool, not a viable alternative to the wholist-analytic ratio. However, it has demonstrated a ratio method, which is not by accuracy, speed and order effects and has provided evidence for the construct validity of the wholist-analytic dimension whilst casting doubt on the validity of the wholist-analytic ratio method.

## 9.5 Chapter summary and conclusions

The wholist-analytic ratio has been shown to be sensitive to reflective-impulsive style and part-whole processing styles and a link between reflective-impulsive style and part-processing style has been demonstrated.

The influence of reflective-impulsive style on the wholist-analytic ratio stems from the lack of counterbalancing of the matching figure and embedded figure subtests. This finding casts doubt on the validity of the CSA in its current form and suggests that the discriminatory power of the wholist-analytic dimension may be attributed to the differences in reflective-impulsive style rather than differences in part-whole processing.

The ability of the wholist-analytic ratio to measure part-whole processing is further reduced by an asymmetry in the nature of processing being compared amongst analytics and wholists. Analytics are being compared based on the efficacy of a part processing strategy across congruent and incongruent tasks and the wholists are being more appropriately compared by their relative ability to whole process and part process.

The influence of reflective style can be rectified by a revision of the CSA to include effective counterbalancing but the asymmetry will be more difficult to address; a whole processing task is required to replace the existing matching figures task, which does not allow for the use of a part processing strategy.

Whilst the wholist-analytic ratio has been demonstrated to have low validity, the construct validity of the wholist-analytic dimension has been supported. Evidence has been provided that wholists and analytics are characterised by a tendency to whole process and part process, respectively, and part and whole processing has been linked with reflective and impulsive approaches, respectively.

The next chapter examines the effect of reflective-impulsive style, demonstrated here, on the reliability of the wholist-analytic dimension, testing the explanation put forward in Chapter five that the theory of diminished reflection can account for the low temporal reliability, which has been reported in the literature.

## **Chapter 10:**

### **Testing the Effect of Diminished Reflection On the Reliability of the Wholist-Analytic Ratio**

## **Chapter 10: Testing the effect of diminished reflection on the reliability of the wholist-analytic ratio.**

### **10.1 Chapter Introduction**

The sensitivity of the wholist-analytic ratio to individual differences in reflective-impulsive style, which was theorised in Chapter four and demonstrated in Chapter nine, will diminish with subsequent test sessions. This theory of diminished reflection was postulated in Chapter five and will be tested here.

The theory of diminished reflection argues that the characteristic tendency of reflective individuals to approach early test items with caution during situations of uncertainty will diminish when tested on a subsequent occasion because prior experience of the trials leads to reduced uncertainty and a reduction in reflective behaviour. The diminishing effect of reflective style will reduce the stability of the ratios between the test and retest sessions. This leads to four hypotheses, outlined in 11.1.1, 11.1.2, 11.1.3 and 11.1.4, respectively.

#### **10.1.1 When the matching figure subtest is presented first, the diminishing effect of reflective style will cause analytic individuals to produce lower analytic ratios at retest.**

In the WAS-WA, the CSA (Riding, 1991) and the replica and parallel forms of the CSA, the CSA-A and CSA-B (Peterson et al., 2003), the matching figure trials are presented first followed by the embedded figure trials; participants with a reflective style and participants with a part processing style will be slowest during the matching figure test items at the first test session and will therefore produce analytic ratios.

Reflective-part processors will produce inflated analytic ratios at the first test session owing to the influence of their part processing style and their reflective style.

At the second test session the effect of reflective style will diminish, part processors will still produce analytic ratios but the ratios will not be inflated by concomitant reflective style characteristics. Therefore, those who were labelled as analytic at the first session because of their complimentary reflective and part processing style will produce lower wholist-analytic ratios at the retest session because the retest ratio will be based on their part processing style and not on their reflective style. The effect of diminished reflection can be further illustrated by the greater impact it will have on the wholist-analytic ratio when the subtest order is reversed.

**10.1.2 When the embedded figure subtest is presented first, the diminishing effect of reflective style cause reflective individuals to swing from producing wholist ratios to producing analytic ratios.**

In the WAS-AW the embedded figures subtest is presented first, therefore, reflective individuals will be slower at the embedded figures tasks because these tasks appear at the beginning of the test and part processors will be slower at the matching figures items because these items are more suited to whole processing. Consequently, the concomitant tendency to be both reflective and a part processor will be in conflict.

This means that many of the participants labelled as wholists at the first sitting are actually reflective individuals who were relatively slower at the embedded figure items than the matching figure items because the embedded figures trials were presented earlier in the test not because of differences in whole or part processing tendencies. The influence of reflective style will again diminish at the retest session and the reflective individuals, who had previously been labelled as wholist, will

produce more analytic ratios because their concomitant part processing style is no longer in conflict with their reflective style.

This theory can also account for the relatively higher temporal reliability of Petersons C-CSA. This extended eighty-item test presents the wholist and analytic subtests twice by combining the replica form CSA-A and the parallel form CSA-B. If a respondent completes the CSA-A first and then after a 5 minute break completes the CSA-B then the CSA-A is likely to be influenced by reflective style as described above and this effect will be diminished in CSA-B because the response uncertainty has diminished. This could account for the lack of relationship reported by Peterson between the CSA-A and the CSA-B ( $r = 0.07$ ). When the two modified forms of the CSA are combined to form the C-CSA, the combined measure is less influenced by the effect of reflective style at the first test session and will therefore produce improved correlations at retest.

Based on the above the WAS Analysis has made a number of improvements to the wholist-analytic ratio methodology which will reduce the influence of reflective style and therefore improve the temporal reliability.

**10.1.3 The improved methodology of the WAS analysis will reduce the influence of reflective-impulsive style at the first test session and therefore temporal stability should be greater for the WAS-WA than for the CSA, the CSA-A and the CSA-B.**

The WAS analyses have been improved in two ways; there has been a change to the standardised instructions to remove the bias towards speed or accuracy and practice items prior to each subtest.

### *The effect of speed and accuracy instructions on test-retest reliability*

Rezaei and Katz (2004) reported the highest test-retest reliability when speed was emphasised at the outset of the CSA. This verbal instruction to focus on speed is likely to temper the standardised computer presented instructions at the beginning of the wholist subtest that state “work carefully to ensure accuracy”.

The CSA’s instructions, which encourage caution and accuracy, will reinforce reflective tendencies to carefully consider each response to ensure accuracy. Rezaei and Katz (2004) additional verbal instructions, which emphasised speed, have to some extent reduced reflective tendencies and increased their rate of responding to the first subtest which can account for the higher temporal reliability reported.

The WAS analysis emphasises both speed and accuracy, presenting balanced and consistent instructions before and throughout the test. Verbal instructions at the outset of the test state “Work as quickly and accurately as you can” and onscreen instructions at the beginning of each subtest state “please respond as quickly and accurately as you can to each item”.

These instructions remove the bias, which is present in the CSA which encourages caution and accuracy at the start of the matching figures section but not at the outset of the embedded figures subtest.

The modified instructions create a more consistent approach across both subtests, which will reduce the tendency of reflective participants to cautiously respond to the matching figure items relative to the embedded figure items. The modifications should improve the temporal stability of the wholist-analytic ratio because they reduce the influence of reflective style on the wholist-analytic ratio at the first test session.

### *The effect of practice items on test-retest reliability*

The WAS analysis introduces 4 practice items at the outset of each subtest. Two of the practice items are 3 part figures and two are 5 part figures; one item in each pair requires an affirmative response and the other requires a negative response. The opportunity to complete the practice items will reduce some of the uncertainty surrounding the tasks and since uncertainty encourages reflection the practice items should serve to reduce the influence of reflective style at the first test session and therefore improve temporal reliability across test and retest sessions.

The expected increase in temporal reliability stems from the improved validity of the measure at the first test session. The revised methodology of the WAS analysis reduces the confounding influence of reflective-impulsive style. The practice items before each subtest will reduce the reflective tendency to respond cautiously to early trial items and the consistent instructions will ensure that reflective individuals are equally likely to focus on accuracy or speed across both subtests. By reducing the influence of reflective style the wholist-analytic ratio is a more valid measure of part-whole processing differences. The increased validity will be demonstrated by improved internal consistency.

#### **10.1.4 Internal consistency will be greater for the WAS-WA than for the CSA, the CSA-A and the CSA-B**

Unfortunately, the CSA does not provide individual item data, therefore, the split half reliability of the WAS analysis will be compared to the internal consistency of the modified forms of the CSA reported by Peterson et al. (2003). They used a sample of 50 participants sitting the test for the first time and performed split half reliability test by comparing the odd responses against the evens. The CSA-A produced a split half reliability of 0.62 and the CSA-B produced a reliability of 0.56

but the highest consistency was obtained when the CSA-A and the CSA-B were combined. The combination of parallel and replica forms was referred to as the C-CSA, now called the E-CSA (Peterson and Deary, 2006), and achieved split half reliability of 0.69.

## **10.2 Method**

### **10.2.1 Participants and materials**

193 undergraduates completed the WAS analysis at the first test session (sample described in Chapter nine). Two months later, 89 students from the same cohort completed the WAS analysis at the second test session. 23 of the 89 participants had not been present during the first test session and 11 participants completed different versions of the WAS analysis at each test session so their results were discarded.

The remaining sample of 55 participants included 27 who completed the WAS-AW during both test sessions and 28 who completed the WAS-WA. There was no significant difference between the age and sex for samples in each test condition ( $t = -.338$ ,  $df = 53$ ,  $p = .737$  and  $X^2 = .007$ ,  $df = 1$ ,  $p = .931$ , respectively), see figure 10.1 for a breakdown.

**Table 10.1: Participants Age and Sex**

<b>Test Condition</b>	<b>N</b>	<b>Sex</b>	<b>Mean Age</b>	<b>Std. Dev.</b>
<b>WAS-AW</b>	27	8M, 19F	22.26 yrs	7.84 yrs
<b>WAS-WA</b>	28	8M, 20F	21.68 yrs	4.55 yrs

### **10.2.2 Procedure**

At the first test session the experimenter visited all first and second year research methods workshops during a one-week period (five, first year workshops and three, second year workshops), all students present were invited to take part in a research study for course credit. The workshops were labelled 1-8; the WAS-WA was completed during odd numbered workshops and the WAS-AW was completed during even numbered workshops.

Two months later, at the second test session workshops were revisited and all students present were invited to complete the WAS analysis for a second time. The WAS-WA and the WAS-AW were again completed during odd and even numbered workshops, respectively, thereby ensuring that the majority of students took the same version of the test at the first and second sitting.

### 10.3 Results

#### 10.3.1 When the matching figure subtest is presented first, the diminishing effect of reflective style will cause analytic individuals to produce lower analytic ratios at retest.

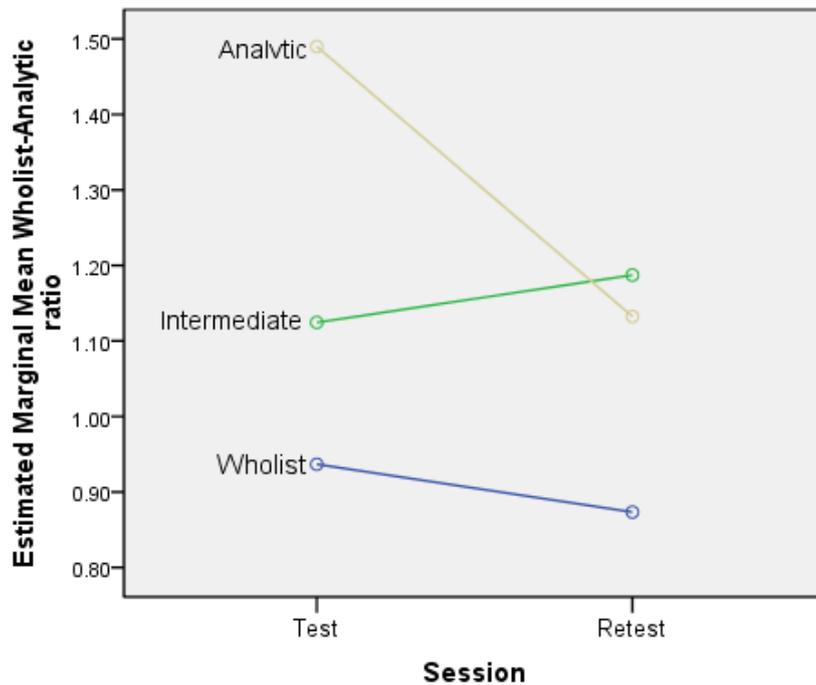
A multivariate ANOVA was employed with wholist-analytic style at session one as the between subjects variable (three levels; wholist, intermediate, analytic) and test session as the within subjects variable (two levels; test and retest).

A significant main effect of style was found ( $F_{1, 15} = 10.441, p = .001$ ), Bonferroni post hoc tests confirmed that those labelled as wholist at the first test session were more wholist overall than intermediates ( $p = .015$ ) and analytics ( $p = .001$ ) when both sessions were considered; the intermediates and the analytics did not significantly differ in their style across both sessions ( $p = .113$ ); means of 0.91 for wholists, 1.16 for intermediates and 1.31 for analytics.

A significant main effect of test session was found ( $F_{1, 15} = 4.844, p = .044$ ) indicating that mean ratios were lower at the second test session, with means of 1.18 at the first session and 1.06. Interestingly the mean at the first session was skewed towards being more analytic and is comparable to the population sample data for the CSA of 1.25 (Riding, 1998, 2005) but the mean at the second subtest is closer to the perfect ratio mean of 1 suggesting that the population is not generally more analytic and when wholist-analytic style is measured without the confounding influence of reflective-impulsive style the population mean may be closer to one.

In relation to the hypothesis, significant interaction was found between style and test session ( $F_{2, 15} = 6.603, p = .009$ ); a series of post hoc paired t-tests revealed that the analytics produced significantly lower ratios at the retest session, means of 1.49 and

1.13 ( $p = .021$ , Bonferroni corrected  $p < 0.03$ ). Whereas the intermediates and wholists did not produce significantly different means at retest, means of 1.12 and 1.19 for intermediates ( $p = .335$ ) and means of 0.94 and 0.87 ( $p = .510$ ). Therefore the hypothesis was supported, when the matching figure subtest was presented first, the diminishing effect of reflective style caused analytic individuals to produce lower analytic ratios at retest.

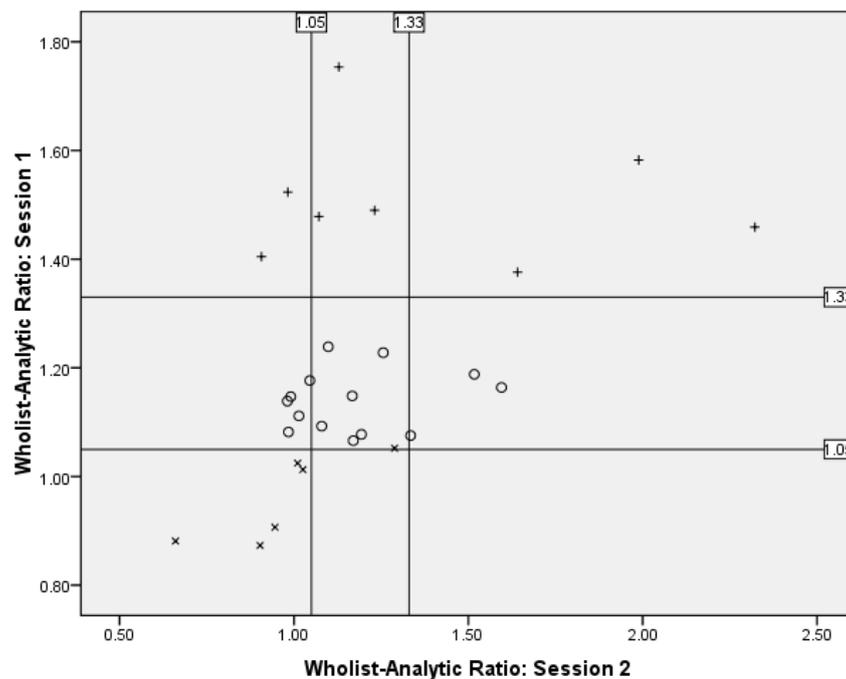


**Figure 10.1: Mean test and retest wholist-analytic ratios by style**

It is clear from Figure 10.1 that it is the analytics that are the greatest source of instability from test to retest. The analytics produced the greatest variation in ratios compared to the intermediates and wholists (.269 compared to .038 and .041, respectively); this pattern persisted even when the ratios were logarithmically transformed to remove the effect of higher ratios creating greater variation (variances of .022 compared to .005 and .009).

Pearson correlations revealed that the test-retest reliability of the WAS-WA was .442 ( $p = .009$ ,  $N = 28$ ). Using the transformed ratios Pearson correlations were performed to find the test-retest reliability by cognitive style. The findings suggest that the source of the instability is those classed as analytics at the first session, with a test-retest correlation of  $r = -.075$  and those classed as intermediates ( $r = .1$ ). The wholists produced a stable test-retest correlation of .795 ( $p = .029$ ).

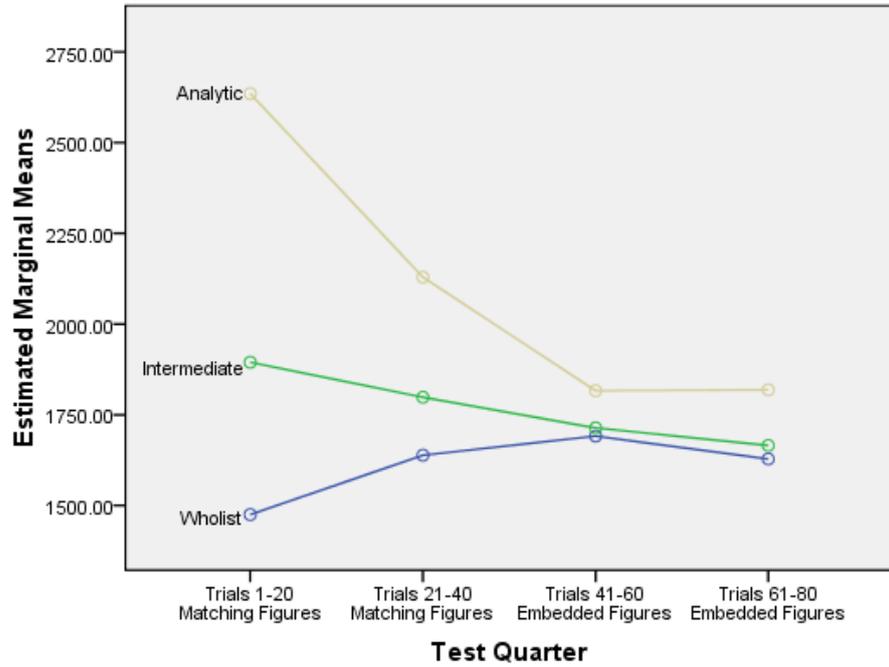
Figure 10.2 illustrates participant ratios at the first test session in comparison to the ratio at the second test session; the cognitive style label derived from the first session identifies participants as wholist, intermediates or analytics.



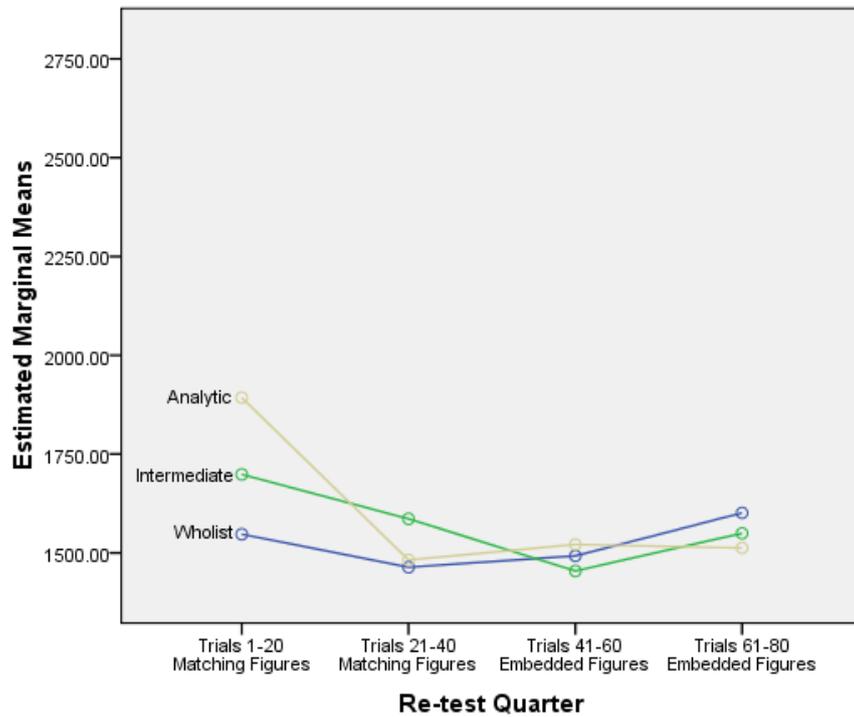
Markers: +(Analytics); o (Intermediates); x (Wholists). Cut Points at 1.05 and 1.33 represent threshold between analytic, intermediate and wholist categories for the WAS-WA.

**Figure 10.2: Comparison of test and retest wholist-analytic ratios for the WAS-WA**

Figures 10.3 and 10.4 clearly show the diminishing effect of reflective style across test quarters and across test sessions.



**Figure 10.3: Test session mean latencies for each test quarter by wholist-analytic style**



**Figure 10.4: Re-test session mean latencies for each test quarter by wholist-analytic style**

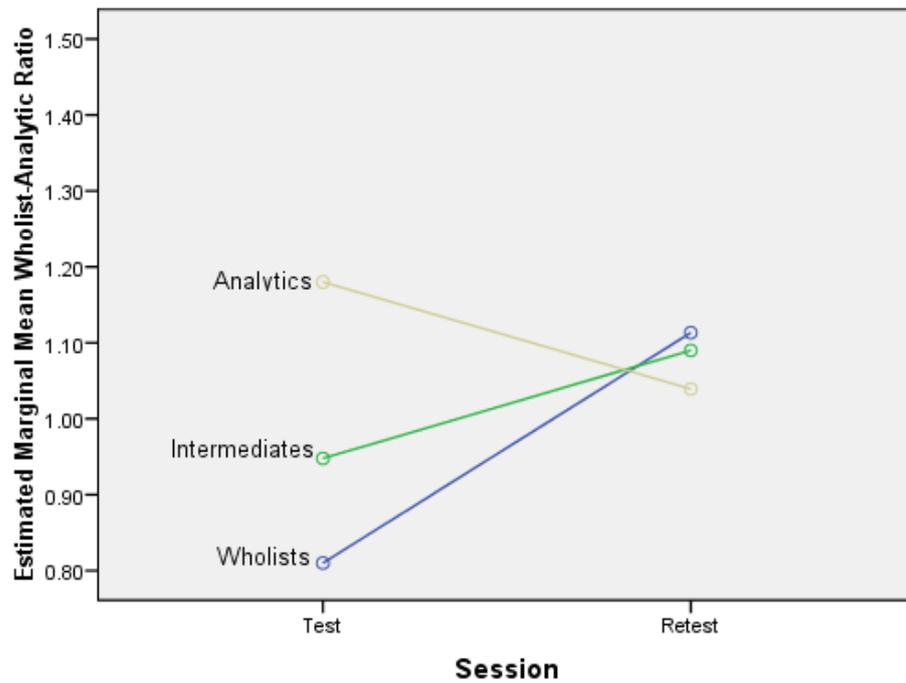
It is predicted that that the WAS-AW will be less stable than the WAS-WA because the diminishing effect of reflective style at retest will have a greater impact on the WAS-AW because the embedded figures subtest is presented first.

**10.3.2 When the embedded figure subtest is presented first, the diminishing effect of reflective style cause reflective individuals to swing from producing wholist ratios to producing analytic ratios.**

A multivariate ANOVA was employed with wholist-analytic style at session one as the between subjects variable (three levels; wholist, intermediate, analytic) and test session as the within subjects variable (two levels; test and retest).

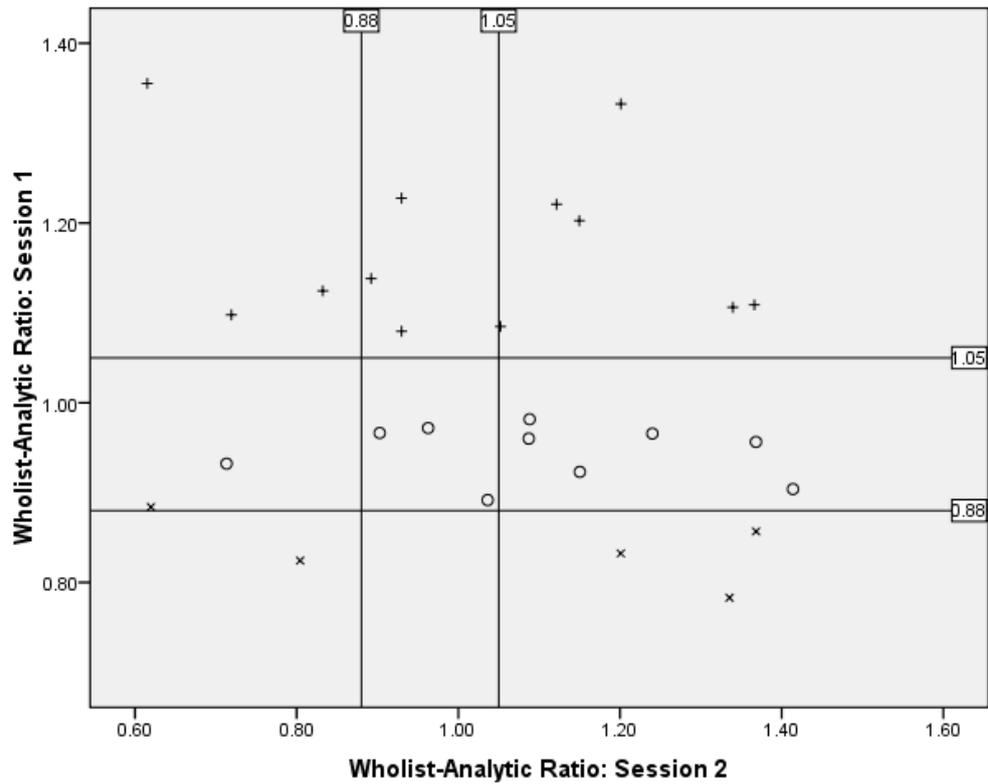
There was no significant main effect of style ( $F_{2, 20} = 2.789, p = .085$ ) and no significant main effect of test session ( $F_{1, 20} = 2.592, p = .123$ ). This means that those labelled as wholists, intermediates and analytics, did not produce significantly different ratios overall, means of 0.96, 1.02 and 1.11, respectively; and there was no significant difference between the overall mean ratios produced at test and retest, means of 0.98 and 1.08, respectively.

There was significant interaction between style and test session ( $F_{2, 20} = 4.923, p = .018$ ) with wholists and intermediates producing more analytic ratios at re-test and analytics producing more wholist ratios. The wholists produced the greatest change; shifting from a mean of 0.88 at the test session to 1.11 and produced the greatest ratio variance of .112 compared to .055 for intermediates and .045 for analytics, providing some support for the hypothesis that reflective individuals labelled as wholists at the first test session will shift to analytic ratios at the re-test session.



**Figure 10.5: Mean test and retest wholist-analytic ratios by style**

As predicted the WAS-AW is less stable than the WAS-WA ( $-0.204$ ,  $p = .153$  compared to  $.442$ ,  $p = .009$ ). This is convincing evidence that the order of presentation of the wholist and analytic subtests can fundamentally affect the stability of the wholist-analytic ratio, since the WAS-AW and the WAS-WA are identical in every other respect.



Markers: + (Analytics); o (Intermediates); x (Wholists). Cut Points at 0.88 and 1.05 represent threshold between analytic, intermediate and wholist categories for the WAS-WA.

**Figure 10.6: Comparison of test and retest wholist-analytic ratios for the WAS-WA**

**10.3.3 The improved methodology of the WAS analysis will reduce the influence of reflective-impulsive style at the first test session and therefore temporal stability should be greater for the WAS-WA than for the CSA, the CSA-A and the CSA-B.**

The improved methodology of the WAS analysis should reduce the influence of reflective-impulsive style at the first test session thereby improving temporal stability

of the WAS-WA. Test retest reliability coefficients are expected to be higher for the WAS-WA than those reported in the literature for the CSA-WA and modified versions of the CSA-WA.

The WAS-WA achieved a test-retest reliability coefficient of .442. This exceeds the 0.30 reported for the CSA-A and the 0.31 reported for the CSA-B (Peterson et al, 2003). It also exceeds the 0.33 and 0.34 reported by Parkinson et al (2004) and the 0.30 reported by Cook (2008) for the unmodified CSA. The WAS-WA exceeds the stability of the CSA reported by Rezaei and Katz (2004) using the one-week interval ( $r = 0.42$ ) and is similar to the stability reported at the one-month interval ( $r = 0.45$ ).

The WAS-WA was not as stable as the CSA using a one month interval when the instructions were manipulated to emphasise speed ( $r = 0.55$ , Rezaei and Katz, 2004) or the extended measure, the C-CSA, reported as  $r = 0.53$  with a one week interval (Peterson et al, 2004).

#### **10.3.4 Internal consistency will be greater for the WAS-WA than for the CSA, the CSA-A and the CSA-B**

Using a split half method, two ratios were calculated based on the odd and even trial items. Care was taken to ensure that each ratio calculation included the same number of yes/no responses and 3/5 part figures. There are ten items of each type therefore, ratio 1 consisted of the odd numbered items in each set of ten and ratio 2 consisted of the even numbered items; this is illustrated in Table 10.2.

Split half reliability statistics were calculated for both versions of the WAS analysis. The WAS-WA and the WAS-AW produced satisfactory split half reliability coefficients of 0.70 and 0.72.

**Table 10.2: Split half reliability – Item breakdown**

<b>Item type</b>	<b>Ratio 1: Items used</b>	<b>Ratio 2: Items used</b>
<b>10 Matching figure items, 3 part, 'yes' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Matching figure items 3 part, 'no' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Matching figure items 5 part, 'yes' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Matching figure items 5 part, 'no' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Embedded figure items, 3 part, 'yes' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Embedded figure items, 3 part, 'no' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Embedded figure items, 5 part, 'yes' response</b>	1,3,5,7,9	2,4,6,8,10
<b>10 Embedded figure items, 5 part, 'no' response</b>	1,3,5,7,9	2,4,6,8,10

There are no reported internal consistency figures for the CSA so the only internal consistency figures to which the WAS analysis may be compared are those reported by Peterson et al (2003). Both versions of the WAS analysis were more stable than Petersons replica form of the CSA, the CSA-A ( $r = 0.62$ ) and the parallel form of the CSA, the CSA-B, ( $r = 0.56$ ). The greatest consistency was obtained when the CSA-A and the CSA-B were combined to form the C-CSA. This extended test achieved a

reliability of 0.69, making it marginally less stable than the WAS-WA and the WAS-AW.

## **10.4 Discussion**

### **10.4.1 The diminishing effect of reflective style on the stability of the WAS-WA and the WAS-AW**

The WAS-AW and the WAS-WA both demonstrate good internal stability with split half correlation coefficients of 0.70 and 0.72, respectively. However, when temporal stability is compared, the WAS-WA is moderately stable at  $r = 0.44$  but the WAS-AW is not stable producing a non-significant, weak, negative correlation of  $-.204$ .

#### ***The source of reduced stability in the WAS-WA***

The theory of diminished reflective style predicted that the source of instability in the WAS-WA would be the analytic group who, with the diminished influence of reflective style, produce less analytic ratios at retest. The findings were consistent with the theory; the test-retest correlations suggest that both the analytic and the intermediate group produced unstable test-retest ratios of  $-.075$  and  $.1$ . As expected the wholists produced a stable test-retest correlation of  $.795$ .

#### ***The source of instability in the WAS-AW***

It was further predicted that the diminished influence of reflective style would have a greater impact on the stability of the WAS-AW and the source of the instability

would be the wholist group shifting from wholist to analytic order ratios. This was supported by the negative test-retest ratio of  $-.561$  produced by the wholists.

Some unexpected findings were that the analytic and intermediate groups also produced unstable test-retest correlations of  $-.2$  and  $-.108$ , respectively. This is relatively easy to explain for the intermediates since some of the intermediates are likely to have a reflective style; the necessarily arbitrary 30% cut off point is likely to create an overlap with a proportion of the reflective respondents being labelled as intermediates. The wholist and intermediate groups are likely to be a mixture of reflective respondents and true wholists, therefore at retest the wholists will produce similar ratios as they did in session one and the reflective respondents will produce more analytic ratios.

It is more difficult to explain why the analytic participants produced unstable ratios; the analytic group are likely to consist of part processors who do not have a concomitant reflective style or they are intermediates, who were placed in the highest 30% ratios because, in relation to the reflective participants and the wholist participants, they did produce higher ratios. It is possible that a proportion of those classed as analytic at the first session have a weak concomitant reflective style.

#### **10.4.2 Comparing the temporal reliability of the WAS-WA with the CSA and similar modified forms of the CSA**

The theory of diminished reflective style predicts that the effect of reflective style will confound any measurement of wholist-analytic style that does not counterbalance the presentation order of wholist and analytic subtests. The effect of reflective style will be present during the first test session and will diminish in subsequent sessions leading to reduced temporal reliability.

It follows then that any modified versions of the CSA, which successfully reduce the influence of reflective style at the first test session, will be expected to demonstrate improved temporal reliability.

The WAS-WA has two methodological improvements that are intended to reduce the influence of reflective style; these are 1) the inclusion of bias free instructions, which emphasise both accuracy and speed, and 2) the inclusion of practice items to reduce uncertainty. The WAS-WA should be more reliable from test to retest than the CSA and modified forms of the CSA that do not control for the influence of reflective style.

The WAS-WA demonstrated moderate test-retest reliability of  $r = .44$  and is therefore more stable over time than the unmodified CSA-WA,  $r = 0.33$  and  $0.34$  (Parkinson et al, 2004) and  $r = 0.30$  (Cook, 2008); and, more stable than the replica and parallel forms of the CSA-WA,  $r = 0.30$  and  $0.31$ , respectively (Peterson et al, 2003). The changes in the WAS-WA methodology to reduce the influence of reflective style appear to have improved the test-retest reliability.

The stability of the WAS-WA is comparable to the reliability coefficients reported by Rezaei and Katz (2004). They tested an unmodified form of the CSA with a one week and a one month retest interval, reporting temporal reliability of  $r = 0.42$  and  $0.45$ . It is unclear whether Rezaei and Katz used ratio or category data for their test-retest correlation; in the absence of a statement to the contrary it will be assumed that untransformed ratio data was used. The CSA has been used without modification and yet has produced higher stability than previous reports of  $0.30$  to  $0.34$  with comparable test retest intervals. With the limited information available regarding these reliability figures there is no real explanation for the improved stability. It would have been useful to compare the ratio variances to assess whether there is any difference in the sample spread of ratios that would have an impact on the stability

but there is insufficient data reported by Rezaei and Katz (2004) to enable such analysis.

It is unclear then whether the modifications to the WAS-WA have led to improvements in temporal stability; when compared with unmodified versions of the CSA it shows improvement over 4 out of 6 of the reported test-retest studies but demonstrates equivalent stability with the other two.

The versions of the CSA which have greater stability than the WAS-WA are the modified CSA which emphasised speed,  $r = 0.55$  (Rezaei and Katz, 2004) and the extended C-CSA which altered the order of presentation,  $r = 0.53$  (Peterson et al, 2003). These findings are consistent with the theory of diminished reflectivity.

The WAS-WA removed the biased instructions that are a feature of the CSA, which encourage reflective characteristics when approaching the wholist subtest, but not in relation to the analytic subtest. The WAS-WA replaced them with consistent, balanced instructions, which emphasised accuracy and speed at the beginning of each subtest. However, it appears that Rezaei and Katz approach, which biased instructions against reflective characteristics, is more effective in reducing the influence of reflective style. This may account for the increased stability ( $r = .55$ ) reported when overall speed was emphasised.

The C-CSA also demonstrated greater stability than the WAS-WA and this is likely to be due to the changes in presentation order that is a feature of the C-CSA. The C-CSA was formed by combining the responses on the 40 item CSA-A, a replica version of the CSA, with the responses on the 40 item CSA-B, a parallel form of the CSA. This post hoc treatment of the data was performed to examine the effect of increased trials on stability. Since the C-CSA was developed from two tests it inevitably consisted of four subtests with a total of 80 trials; 20 matching figure trials followed by 20 embedded figure trials then, after a five minute break, a further 20

matching figure trials and 20 embedded figure trials. The subtest presentation order was constant and preserved the order of the CSA but the repetition served to reduce the influence of reflective style and this can account for the improved stability at retest ( $r = 0.53$ ).

#### **10.4.3 Internal consistency: Comparing the WAS-WA with Peterson's modified versions of the CSA.**

There are no internal consistency data for the CSA because the individual items are not open to analysis, therefore the only statistics available for comparison with the WAS analysis is Peterson et al's (2003) CSA-A, CSA-B AND C-CSA. Both the WAS-WA and the WAS-AW are internally stable,  $r = 0.72$  and  $0.70$ , respectively. They are more stable than the CSA-A ( $r = 0.62$ ) and the CSA-B ( $r = 0.56$ ) and are comparable to the stability reported for the C-CSA of  $r = 0.69$ .

The greater internal stability of the WAS analyses and the C-CSA may be a statistical artefact of having double the items than that of the CSA-A and the CSA-B. This is good in terms of reliability but doesn't make them more valid than the shorter tests. Alternately, the extended trials may better capture the differences in part-whole processing and be less influenced by reflective style because the effect is lessened across a greater number of trials. However, it is clear from the temporal reliability data that the WAS-WA and the WAS-AW is still confounded by reflective-impulsive style despite an improved methodology. The WAS analyses and the C-CSA are internally stable but whether they are consistently measuring reflective-impulsive style or part-whole processing style is to be determined.

#### **10.4.4 Conclusion**

The difference in temporal reliability between the WAS-WA and the WAS-AW illustrates the confounding effect of reflective style on the wholist-analytic ratio and the effect of diminishing reflectivity on test-retest stability. The improvements to the WAS analyses methodology, the inclusion of practice items and unbiased instructions, which reduce the effect of reflective style at the first test session, have led to greater temporal stability than unmodified forms of the CSA. Creating a bias in the instructions to encourage overall speed improved stability further; however if satisfactory counterbalancing methods were put in place the influence of reflective style would be removed and instruction bias towards speed or accuracy would be redundant.

The WAS-WA is moderately stable over time and internally consistent but it is not valid because it is confounded by reflective style. The WAS analysis is not intended as an alternative to the CSA it is merely a tool for the purpose of demonstrating the inherent problems of any measure of wholist-analytic style which presents the wholist and analytic subtests without adequate counterbalancing measures.

## **Chapter 11:**

### **Testing the Unidimensional Theory of Wholist-Analytic Style – Part I**

## **Chapter 11: Testing the unidimensional theory of wholist-analytic style – Part I**

### **11.1 Introduction**

The construct validity of the wholist-analytic dimension predicts that the wholist-analytic dimension and other styles in the wholist-analytic family should correlate (Riding, 1991). However, reviews in this area have reported a lack of correlational data to support the unitary perspective of style (Riding and Cheema, 1991). In Chapter three it was demonstrated that the most consistent relationship reported in the literature has been between field independent-dependent style and reflective-impulsive style, specifically when the childrens' embedded figures test has been used as the measure of field independent-dependent style.

There is no correlational evidence linking convergent style with analytic style and no correlational evidence linking the wholist-analytic dimension to any of the five principal style dimensions, reflective-impulsive style, convergent-divergent style, field independent-dependent style, serial-holist style or leveller-sharpener style. The dearth of supporting research has contributed to the move towards a more complex multidimensional view (Hodgkinson and Sadler-Smith, 2003) in favour of the unidimensional perspective (Riding and Cheema, 1991; Allinson and Hayes, 1996).

The aim of the current study is to examine the relationship between the wholist-analytic dimension and two sub-ordinate styles: reflective-impulsive style (Kagan et al., 1964) and convergent-divergent style (Hudson, 1967). The construct validity of the wholist-analytic dimension predicts that analytic individuals should be more reflective and convergent and that wholist individuals should be more impulsive and divergent. The wholist-analytic dimension will also be compared to the analytic-intuitive dimension (Allinson and Hayes, 1996). Since the analytic-intuitive

dimension represents a similar super ordinate global-analytic construct it is predicted that wholists should be more intuitive.

One of the major problems, which confound the styles literature, is the tendency for style measures to be sensitive to the influence of other styles. For this reason care has been taken to employ style measures which control for the influence of such confounding factors.

### **11.1.1 Style Measurements**

#### ***Wholist-analytic Style***

Chapter nine demonstrated that the wholist-analytic dimension is confounded by sensitivity to reflective-impulsive style, which could lead to a difficulty in interpreting any emerging correlations with other styles in the wholist-analytic family. Therefore, the WAS analysis will be employed here as the measure of wholist-analytic style rather than the CSA (Riding, 1991); whilst the WAS analysis is sensitive to both reflective-impulsive style and wholist-analytic style, because it is constructed in the same way as the CSA, it will be possible to obtain a clearer picture of the relationships at work by using both versions of the WAS analysis.

The WAS-WA is expected to correlate with the other style measures; wholists will be more divergent, more impulsive and more intuitive which is consistent with the unitary perspective of style.

The WAS-AW is predicted to have little or no relationship with the other measures; if a relationship emerges it will be in the opposite direction to that predicted by the literature; wholists will appear more reflective, convergent and analytic. This is because the WAS-AW measures conflicting differences in wholist-analytic style and

reflective-impulsive style. In the WAS-AW individuals who are slower at the early test items because of their reflective characteristics will acquire a wholist ratio.

The part-whole ratio derived from the WAS analysis will also be compared to the other styles in the wholist-analytic family; Whole processors are expected to be more intuitive, divergent and impulsive. The relationship between the part-whole ratio and the other measures of style should be consistent across the WAS analysis test versions because the part-whole ratio calculation is not affected by the same methodological limitations which have caused the sensitivity to reflective-impulsive style in the wholist-analytic ratio.

### ***Reflective-Impulsive Style***

Reflective-impulsive style will be calculated based on the response latency to trials in the WAS analysis and the accuracy of the responses. Reflective-impulsive characteristics are stable across a range of tasks and therefore can be measured by any novel task, which measures speed and accuracy (Nietfeld and Bosma, 2003)

The Matching familiar figures test is the traditional measure of reflective-impulsive style but it will not be used here because of reports that the trial items are biased towards analytic processing (Zelniker and Jeffery, 1979), see Chapter eight. The WAS analysis affords an opportunity to measure latency and accuracy in across analytic and global processing tasks thus removing the potential analytic bias associated with the matching familiar figures test.

### ***Convergent-Divergent Style***

The tests employed here have been extensively piloted (see Chapter seven) and they represent a valid measurement of convergent-divergent thinking. They are free from the confounds with ability demonstrated by Al-Naeme, 1991 and Bahar and Hansell, 257

1999; and they consist of a selection of convergent items which have been specifically designed and tested to avoid bias toward analytic processing and the influence of prior knowledge and experience.

### *Analytic-Intuitive Style*

Allinson and Hayes's (1996) Cognitive Style Index will be used to measure analytic-intuitive style. The CSI has been included here because it represents the most reliable and comparable measure of super ordinate style; it has demonstrated sound test retest reliability and internal reliability (Allinson and Hayes, 1996).

## **11.2 Method**

### **11.2.1 Participants**

The sample consisted of 303 participants (75 male, 227 female, 1 not stated), which represented a full cohort of first and second year psychology students. The sample mean age was 22.23 years with a standard deviation of 6.61 years; there was no significant difference in age between the sexes (Males 22.55 yrs, s.d. 6.68 yrs; females 22.12 yrs, s.d. 6.60 yrs).

The students were approached over a period of five weeks during their weekly research methods classes and invited to complete the CSI, two convergent thinking tests (one verbal, one non-verbal), one divergent thinking test (the object uses test) and the WAS analysis. The CSI was administered in the first week, the convergent and divergent tests were administered during the second week (presentation order was counterbalanced) and the WAS analysis was administered over a further two week period; in the final week students who were absent during any of the test

sessions were invited to complete any of the tests they had missed. Students received partial course credit for participation.

Of the total sample, 218 students completed the CSI (52 male, 166 female), with a mean age of 22.83 years and a standard deviation of 7.31 years (Males 22.85, 7.35; females 22.83, 7.32).

199 completed the non-verbal convergent test (51 male, 148 female); 199 completed the verbal convergent test (57 male, 142 female); 146 participants completed both convergent thinking tests. 216 completed the divergent thinking test (56 male, 160 female).

To calculate a relative measure of convergent-divergent style respondents must obtain both a convergent and divergent score; 154 completed the verbal convergent test and the divergent test; 161 completed the analytic verbal test and the divergent test; 121 completed all three tests.

130 participants completed the WAS analysis (35 male, 95 female), 117 of which had also completed the CSI, 101 had also completed at least one of the convergent tests plus the divergent test. 73 completed the entire battery of tests.

### **11.2.2 Data Analysis**

To examine the relationship between the styles in the wholist-analytic family each measure was manipulated so that it produced a score in the form of a continuous variable.

### ***Convergent-Divergent Style***

Convergent – Divergent style was measured by comparing the relative performance on the object uses test, the VCT and the NVCT (measurements described in full in Chapter seven). Performance on the convergent and divergent tests was standardised as Z scores and participant's position on the convergent-divergent dimension was calculated by subtracting the convergent score from the divergent score; therefore, lower scores indicate relatively more convergent thinking and higher scores indicate relatively more divergent thinking.

### ***Analytic – Intuitive Style***

The 38-item Cognitive Styles Index (CSI) (Allinson and Hayes 1996) was used to measure analytic-intuitive style. This self-report instrument invites respondents to indicate a true, uncertain or false response to 21 statements that relate to the analytic pole and 17 that relate to the impulsive pole. True, uncertain and false responses are given 0, 1 or 2 points, respectively and scores are reversed for impulsive items. The CSI has a theoretical minimum and maximum score of 0 and 76, with a perfect mean of 38. Lower scores indicate a more intuitive cognitive style and higher scores indicate a more analytic style.

### ***Wholist – Analytic Style***

Wholist-analytic style was measured using the WAS analyses; the median time taken to complete the matching figures section was compared to the median time taken to complete the embedded figures section producing a ratio for each participant. Lower ratios indicate a more wholist style whereas higher ratios indicate a more analytic style.

### *Reflective – Impulsive Style*

The time taken to complete the WAS analysis and the accuracy with which it was completed was measured. The completion time was based on the sum of both the matching figures and the embedded figures subtests and is therefore not confounded by wholist-analytic style; accuracy was measured as percentage of items completed correctly. Time and accuracy were standardised as Z scores and summed to produce a scale for which high scores indicate a more reflective style and low scores indicate a more impulsive style.

**Table 11.1: Distribution of Style Scores**

<b>Style</b>	<b>Min.</b>	<b>Mean</b>	<b>Max.</b>	<b>Kolmogorov Smirnov</b>
<b>Convergent-Divergent</b>	-2.85	0.15	3.99	Z =0.739, p=0.646
<b>Analytic-Intuitive</b>	11.00	41.24	68.00	Z =0.991, p=0.280
<b>Reflective-Impulsive</b>	-4.04	0	3.78	Z =0.810, p=0.528
<b>Wholist-Analytic</b>	0.38	1.10	2.32	Z =1.525, p=0.019

All of the style measurements demonstrated a satisfactory distribution with the exception of the wholist-analytic scores ( $Z =1.525$ ,  $p=0.019$ ); this is to be expected given the findings in Chapter nine. There is a significant and substantial difference between the range and level of scores derived from the different versions of the WAS analysis. The findings of Chapter nine are replicated here with WAS-AW respondents appearing more wholist than the WAS-WA respondents. When the

distribution of scores for each test version are examined separately the scores are approximately normally distributed, see Table 11.2 below.

**Table 11.2: Distribution for each version of the WAS Analysis**

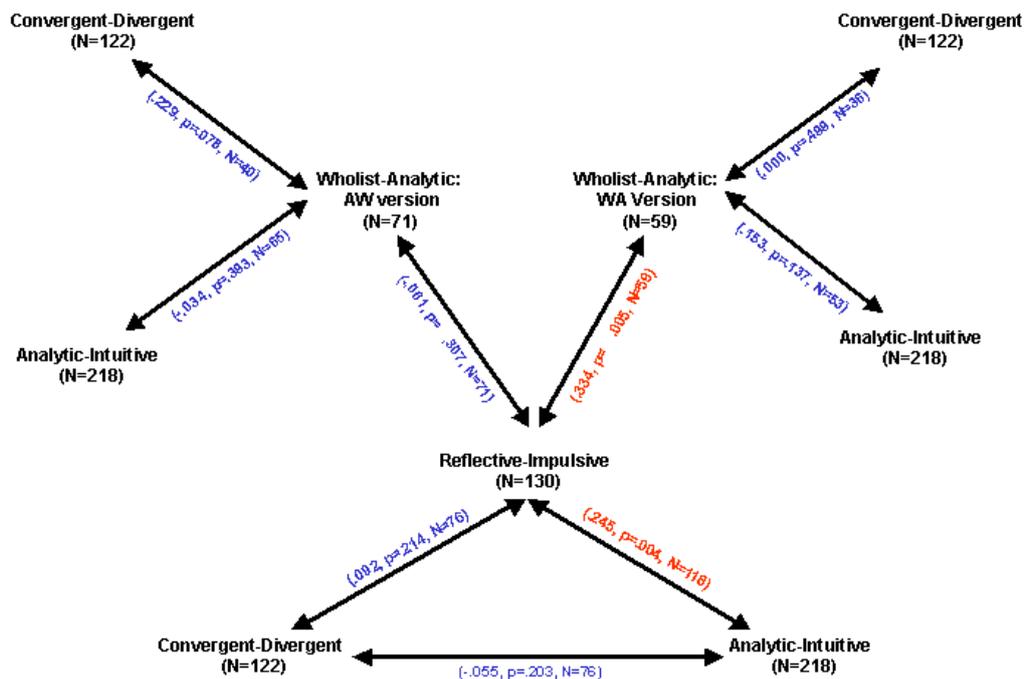
<b>Wholist-Analytic Style Test Version</b>	<b>Min.</b>	<b>Mean</b>	<b>Max.</b>	<b>Kolmogorov Smirnov</b>
<b>WAS-AW</b>	0.38	0.98	1.64	Z=1.049, p=0.221
<b>WAS-WA</b>	0.72	1.24	2.32	Z=0.774, p=0.587

### 11.3 Results

Pearson correlations were employed to examine the relationship between wholist-analytic style, convergent-divergent style, reflective-impulsive style and analytic-intuitive style. The wholist-analytic ratios produced by each version of the WAS test were input as separate variables, see Figure 11.3.

Two significant relationships emerged (presented in red in Figure 11.1) Reflective-impulsive style correlated with analytic-intuitive style ( $r = .245$ ,  $p = .004$ ); reflective individuals reported that they were more analytic and impulsive individuals reported that they were more intuitive.

Reflective individuals produced significantly more analytic ratios when wholist-analytic style was measured by the WAS-WA ( $r = .334$ ,  $p = .005$ ) but not when the WAS-AW was used ( $r = -.061$ ).

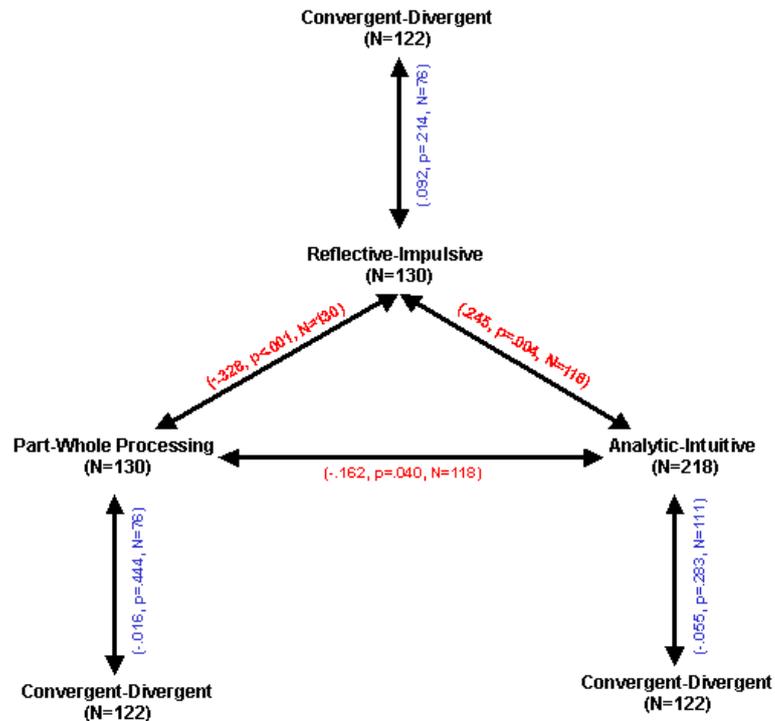


**Figure 11.1: Pearson correlations (1 tailed) – Relationship between styles**

There was no relationship between convergent –divergent style and the other styles: analytic-intuitive ( $r = -.034$ ); wholist-analytic style ( $r < .001$ ); or reflective-impulsive style ( $r = .092$ ).

Pearson correlations were also performed using the part-whole ratio, which was introduced in Chapter four and validated in Chapters six and nine. The part-whole ratio was designed to reveal a tendency to approach matching figures task using part processing or whole processing. Lower part-whole ratios indicate part processing and higher ratios indicate whole processing. The advantage of this measurement over the wholist-analytic ratio is that it offers a measure of part - whole processing

which is not influenced by the order in which subtests are presented and therefore not confounded by reflective-impulsive style. The relationship between part-whole processing style, reflective-impulsive style, analytic-intuitive style and convergent-divergent style is illustrated below.



**Figure 11.2: Style relationships with Part-Whole processing ratio**

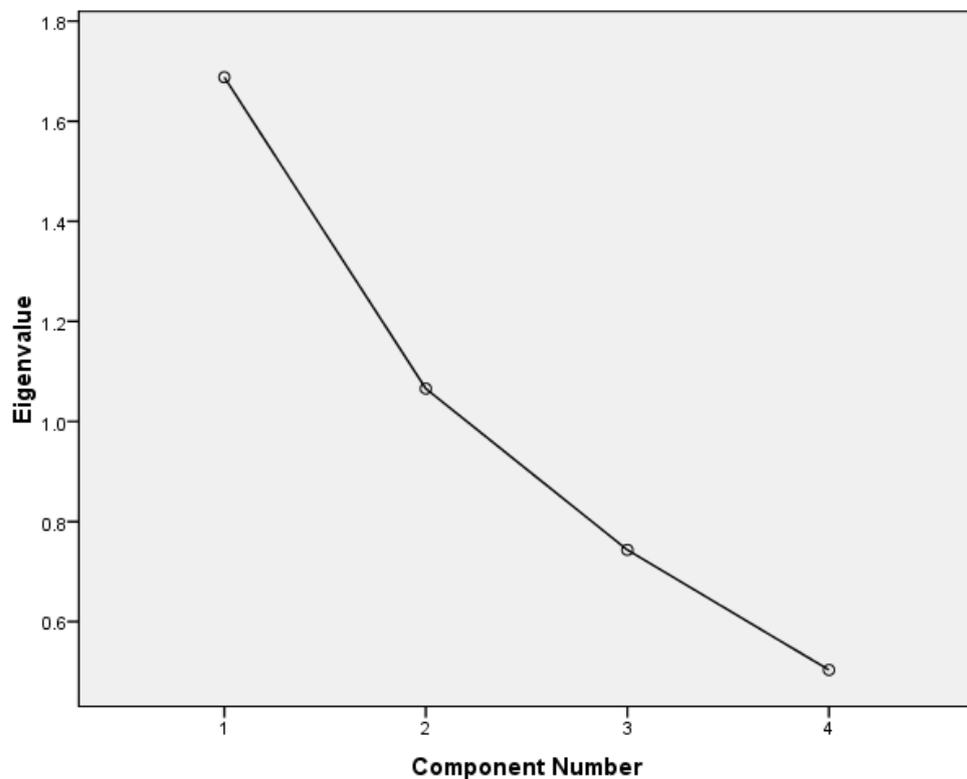
The findings suggest that convergent-divergent style is independent of part-whole processing preferences, analytic-intuitive style and reflective-impulsive style ( $r = .016$ ;  $r = .055$ ; and  $r = .092$ , respectively).

It also appears that there was a reciprocal relationship between reflective-impulsive style, analytic-intuitive style and part-whole processing preferences. However, the weak correlation between part-whole processing preferences and analytic-intuitive

style was spurious and mediated by reflective-impulsive style. When the effects of reflective-impulsive style are partialled out the coefficient suggests that part-whole processing and analytic-intuitive style are independent ( $r = .088$ ,  $p = .172$ )

### 11.3.1 Principle component analysis

The style scores for the 74 individuals who completed the entire battery of measurements were entered into a principle component analysis. Two factors with Eigenvalues greater than one were extracted which accounted for 69% of the variance.



**Figure 11.3: Scree plot for showing principle components derived from CSI scores, reflective-impulsive scores, convergent-divergent score and part-whole processing ratio**

Reflective-impulsive style (.813); part-whole processing (-.799); and analytic-intuitive style (.620) loaded on factor one which explained 42% of the variance. Convergent-divergent (.930) loaded on it's own on factor two, explaining 27% of the variance.

**Table 11.3: Correlation matrix and summary data for Analytic-Intuitive style scores (A-I), reflective-impulsive scores (R-I), convergent-divergent score (C-D) and part-whole processing ratio (P-W)**

	<b>P-W style</b>	<b>A-I style</b>	<b>C-D style</b>	<b>R-I style</b>
<b>P-W style</b>	<b>r = 1.000</b>	p = .015	p = .379	p < .001
<b>A-I style</b>	<b>r = -.252</b>	<b>r = 1.000</b>	p = .128	p = .009
<b>C-D style</b>	<b>r = .036</b>	<b>r = -.134</b>	<b>r = 1.000</b>	p = .285
<b>R-I style</b>	<b>r = -.481</b>	<b>r = .276</b>	<b>r = .067</b>	<b>r = 1.000</b>

*Note: Significance levels above the diagonal; correlation coefficients below the diagonal*

A Varimax rotation with Kaiser normalisations converged in three iterations on the matrix in table 11.4. Component one was characterised by part processing style, analytic style and reflective style and component two was characterised by convergent style. The results of the principle component analysis presented here should be considered with a degree of caution, since they have been performed on

seventy-four participants when the minimum recommended sample is one hundred people (Kline, 2000)

**Table 11.4: Rotated Varimax matrix with Kaiser transformation for Analytic-Intuitive style scores (A-I), reflective-impulsive scores (R-I), convergent-divergent score (C-D) and part-whole processing ratio (P-W)**

Style Measures	Components	
	1	2
P-W style	-.804	
A-I style	.560	
C-D style		-.928
R-I style	.838	

### 11.3.2 Validity of the part-whole processing preference ratio

The construct validity of the part-whole processing dictates that the embedded figures ratio should not correlate with the part-whole ratio, reflective-impulsive style, convergent-divergent style or analytic-intuitive style.

A two-tailed Pearson correlation revealed that the embedded figure ratio did not significantly correlate with wholist-analytic style ( $r = .106$  and  $-.204$ ,  $p = .380$  and  $.122$ , for WAS-AW and WAS-WA respectively) reflective-impulsive style ( $r = -.051$ ,

$p = .564$ ), part-whole processing preference ( $r = .010$ ,  $p = .913$ ) or analytic-intuitive style ( $r = -.051$ ,  $p = .587$ ). Additionally, when entered in the principle component analysis with the other variables, the embedded figure ratio did not load sufficiently on factor one ( $-.351$ ) or factor two ( $.371$ ).

This suggests that the part-whole ratio is indeed measuring part-whole processing differences and not merely the ability to process figures of greater complexity; these findings replicate those in Chapter nine.

#### **11.4 Discussion**

Convergent-divergent style did not correlate with analytic-intuitive style, reflective-impulsive style, wholist-analytic style or the new measure of part-whole processing preferences. This is consistent with the styles research presented in Chapter 3, which yields no empirical evidence linking convergent-divergent style with other styles in the wholist-analytic family.

There was a weak correlation between analytic-intuitive style and part-whole processing preferences but this was found to be a spurious association resulting from their mutual relationship with reflective-impulsive style.

The only relationships, which have emerged from the present study, have involved reflective-impulsive style. This is again consistent with the styles literature, presented in Chapter nine, which revealed that the only relationships that have been reported have been between reflective-impulsive style and field independent-dependent style.

The relationship between reflective-impulsive style and wholist-analytic style is likely to have been an artefact of the wholist-analytic ratio being confounded by

reflective-impulsive differences rather than a genuine link between part-whole processing and reflective-impulsive style. However, the relationship between the part-whole processing ratio and reflective-impulsive style demonstrated an association between part processing and reflective style and between whole processing and impulsive style.

The finding that analytic-intuitive style correlates with wholist-analytic style and reflective-impulsive style but not with part-whole processing style suggests that the CSI is also measuring reflective-impulsive differences rather than global-analytic differences.

#### **11.4.1 Implications for the construct validity of the wholist-analytic dimension and the unitary perspective of style.**

The findings in this study are not generally supportive of the unidimensional perspective of style and cast doubt over the construct validity of the wholist-analytic dimension. However, the results do provide indirect evidence of the link between reflective-impulsive style and part-whole processing.

The finding that the wholist-analytic style ratio only correlates with reflective – impulsive style when the WAS-WA is used but not when the WAS-AW is used demonstrates the complimentary relationship between reflective, part processing styles and impulsive, whole processing styles. The complimentary reflective and part processing styles reinforce each other to produce an analytic ratio in the WAS-WA, which naturally correlates with reflective-impulsive style. However, in the WAS-AW, the complimentary reflective and part processing styles are in conflict, the opposite effects cancel each other out and no relationship emerges between wholist-analytic ratios and reflective-impulsive style. This supports the findings of Chapter nine suggesting that the wholist-analytic ratio measures both wholist-

analytic style and reflective-impulsive style because of the methodological limitations in the form of a lack of adequate counterbalancing which has led to order effects.

The part-whole processing ratio also correlated with reflective-impulsive style; the part-whole ratio is not confounded by order effects and therefore demonstrates a genuine, albeit weak to moderate, relationship between reflective-impulsive style and the defining characteristics of wholist-analytic style, i.e. the tendency for part or whole processing.

The principle component analysis produced two factors, with reflective-impulsive style and part-whole processing preferences loading high with analytic-intuitive style loading moderately high on the first factor and convergent-divergent style loading high on the second factor. These results are similar to Allinson and Hayes (1996) factor analytic study, in that convergent-divergent did not load sufficiently to be included in the CSI items.

### **11.5 Conclusion**

The factor analytic findings and the correlational data have provided further evidence for a relationship between reflective-impulsive style and the part-whole processing preferences, which define Riding's wholist-analytic style. No evidence was found for a relationship between convergent-divergent styles and other styles in the wholist-analytic family. This casts doubt over the construct validity of the wholist-analytic dimension, and any construct, which takes an all-encompassing unidimensional view of global-analytic style. However, there appears to be a consistent relationship between part-whole processing tendencies and reflective-impulsive style. This, combined with the pervasive nature of reflective-impulsive

style across tasks make it all the more important for care to be taken when accuracy and speed are used in the assessment of style.

## **Chapter 12:**

### **Testing the Unidimensional Theory of Wholist-Analytic Style – Part II**

## **Chapter 12: Testing the unidimensional theory of wholist-analytic style – part II**

### **12.1 Introduction**

The previous Chapter demonstrated a relationship between part processing and reflective style and whole processing and impulsive style. This chapter re-examines the relationship between wholist-analytic style, reflective-impulsive style, convergent-divergent style and analytic-intuitive style reported in the previous chapter but this time uses an unmodified version of the CSA and a computer version of the MFFT (described in Chapter eight) to assess wholist-analytic style and reflective-impulsive style respectively.

Chapter eleven found relationships between the wholist-analytic ratio and part-whole processing preferences, reflective-impulsive style and analytic-intuitive style; these relationships were mediated by individual differences in reflective-impulsive style. Based on the previous findings; wholist-analytic style is expected to correlate with reflective-impulsive style such that reflective participants are more analytic. Wholist style is also expected to be associated with intuitive style but this is likely to be a spurious relationship mediated by reflective-impulsive style. No correlation is predicted between wholist-analytic style and convergent-divergent style.

### **12.2 Method**

#### **12.2.1 Participants**

Two student samples were used; sample one consisted of 280 participants and completed the CSA, the CSI and the MFFT and sample two consisted of 51 participants and completed the CSA and the convergent-divergent thinking tests.

### *Sample One*

280 participants took part ( $\mu$  age 21.66 years), representing an entire cohort of first and second year research methods students from academic year 2005/6 and an entire cohort of first year research methods students from academic year 2006/7 (85 males,  $\mu$  age 21.21 years and 195 females,  $\mu$  age 21.86 years). The higher proportion of female students reflects the trend for greater number of females taking psychology courses.

225 participants completed the CSA (69 males and 156 females); 8 people either failed to meet the minimum accuracy level of 85% (Riding, 1991, 1998, 2005) for the wholist-analytic dimension or produced extreme wholist-analytic ratios between 2.74 and 3.94; these data were deleted.

200 participants completed the MFFT, however 81 sets of MFFT results did not successfully convert owing to a computer fault, leaving 119 participants with useable results (37 males and 82 females); 174 participants completed the CSI (45 males and 129 females).

72 participants completed both the CSA and the MFFT and 147 completed both the CSA and the CSI.

### *Sample Two*

58 participants (49 female and 2 male, 7 not stated) with a mean age of 22.73 years (standard deviation 6.25 years) took part; 52 completed the convergent-divergent thinking tests and 46 completed the CSA and 42 participants completed both measures. The convergent thinking test consisted of the non-verbal and verbal tests and the divergent test consisted of the object uses test outlined in Chapter seven and used in Chapter eleven. The convergent and divergent thinking tests had a 15-minute

time limit each and presentation order was counterbalanced, participants were then given a 10 minute break before completing the CSA.

Seven months later 19 participants from the original sample completed the convergent-divergent tests for a second time. Participants were all female and their mean age was 23.47 years, standard deviation 7.69 years. A Pearson correlation revealed excellent test-re-test reliability of  $r = 0.81$  for convergent-divergent style scores; temporal reliability was  $r = 0.92$  for the divergent thinking test and  $r = 0.79$  for the convergent thinking test.

### **12.2.2 Data Analysis**

To aid direct comparisons with the data in the previous chapter, reflective-impulsive style and convergent-divergent style were analysed as continuous variables and a Pearson correlation was performed to assess the relationship between reflective-impulsive style, analytic-intuitive scores, convergent-divergent scores and wholist-analytic ratios.

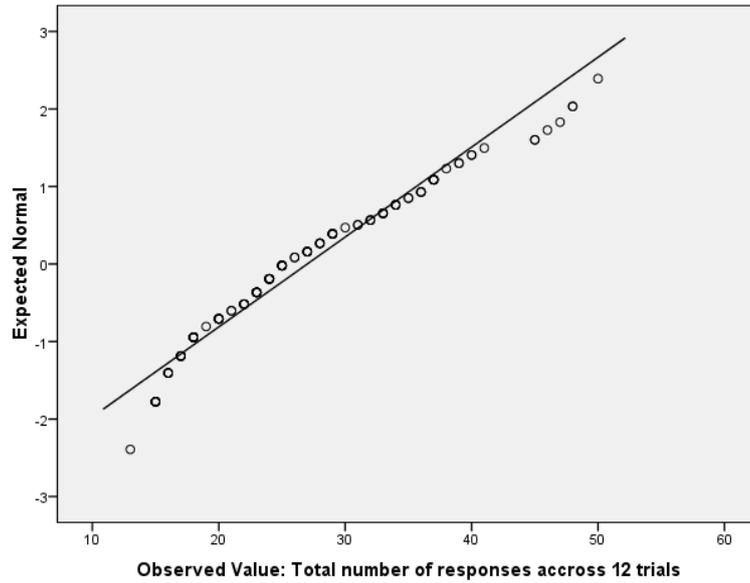
#### ***Wholist-analytic Style Groups***

Wholist-analytic style was measured using the CSA. Higher ratios indicate a more analytic style and lower ratios indicate a more wholist style.

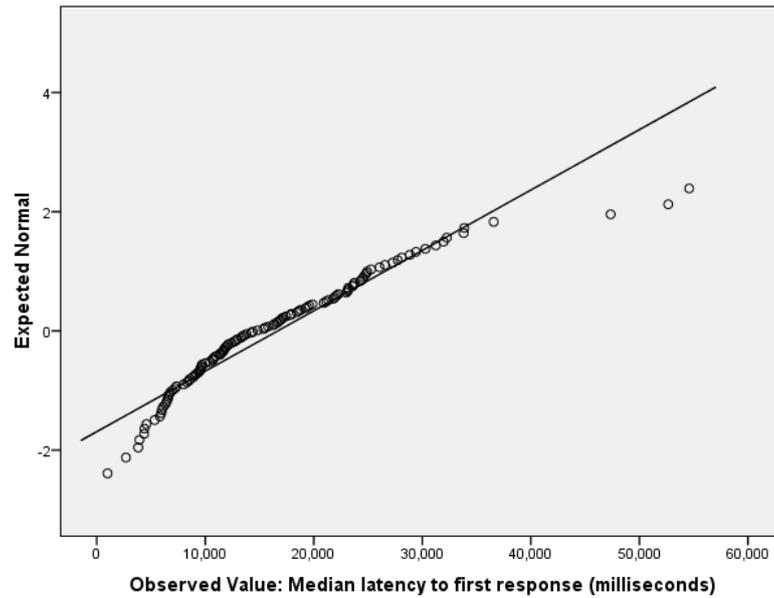
#### ***Reflective-impulsive style scale***

Participants completed the newly constructed computer based Matching Familiar Figures Test; reflective-impulsive style was calculated using the median time taken to complete the MFF items and the total number of attempts it took to achieve correct answers across 12 trials.

Accuracy scores were normally distributed ( $z = 1.234$ ,  $p = .095$ ) with a minimum score of 13 indicating a near perfect score and a maximum score of 50 suggesting that some participants regularly clicked on four of the eight figures before happening upon the correct answer reducing the odds of eventually making the right choice to 50-50.



**Figure 12.1: Normal QQ Plot – Accuracy of responses on matching Familiar Figures Test**



**Figure 12.2: Normal QQ Plot - Latency to first response on the Matching Familiar Figures Test**

Response times were normally distributed ( $z = 1.064$ ,  $p = .207$ ). The normal range for responding was between 1 second and 36 seconds; there were 3 extreme scores with responders taking on average close to a minute to make their choice (minimum and maximum median latencies, 996ms and 54586ms, respectively).

A Pearson correlation showed that ‘latency to first response’ and the ‘number of errors made before the correct answer was achieved’ negatively correlated ( $r = -.554$ ,  $p < .001$ ,  $n = 119$ ) demonstrating that the longer reflection times lead to greater accuracy.

The median latencies to first response and the number of errors made on the matching familiar figures test were standardised as Z scores, standardised error scores were reversed and summed with standardised latency scores to produce a scale in which high scores represent reflective style and low scores represent

impulsive style; fast-accurate and slow-inaccurate participants should achieve intermediate scores.

### ***Convergent-divergent style scale***

Convergent – Divergent style was measured by comparing the relative performance on the object uses test, the VCT and the NVCT (measurements described in full in chapter seven). Performance on the convergent and divergent tests was standardised as Z scores and participants' position on the convergent-divergent dimension was calculated by subtracting the convergent score from the divergent score; therefore, lower scores indicate relatively more convergent thinking and higher scores indicate relatively more divergent thinking.

### ***Analytic-Intuitive Style***

Analytic-intuitive style was measured using the CSI. Higher scores indicate more intuitive style and lower scores indicate a more analytic style. The minimum and maximum scores were 6 and 58, respectively, compared to the theoretical minimum and maximum scores of 0 and 76. The mean CSI score was 33.54, which is close to the theoretical mean of 38. Scores were approximately normally distributed ( $Z = .798$ ,  $p = .547$ ). Lower scores indicate a more analytic cognitive style and higher scores indicate a more intuitive style.

## 12.3 Results

### 12.3.1 Wholist-analytic style and reflective-impulsive style

A one tailed Pearson correlation revealed that wholist-analytic style has a weak, non-significant relationship with reflective-impulsive style ( $r = -.165$ ,  $p = .086$ ). The lack of correlation may to a certain extent be due to the inclusion of fast-accurate and slow-inaccurate participants in the reflective-impulsive scores. In consideration of this, the style groups were analysed by category and a chi squared test employed to assess the relationship between style groups.

#### *Reflective – Impulsive Style Groups*

Reflective and Impulsive individuals were categorised using the double median split method. 54 participants were labelled as ‘Accurate’ and 65 as ‘Inaccurate’, scoring above or below a median of 25 responses over 12 trials. 59 participants were labelled ‘Slow’ and 60 as ‘Fast’, responding above and below the median latency of 14594.50 milliseconds per trial.

42 participants were both slow and accurate which characterised a reflective style and 47 participants were fast and inaccurate which characterised an impulsive style. There was no significant difference in mean age between the groups ( $F = .378$ ,  $df = 3,114$ ,  $p = .769$ , means between 21.83 and 23.94 years) and no significant difference in sex ( $\chi^2 = 0.51$ ,  $df = 3$ ,  $p = .997$ )

**Table 12.1: Classification of reflective - impulsive style**

Labels	N	Latency to first response (ms)			Total no. of responses		
		Median	Min	Max	Median	Min	Maxi
<b>Reflective</b>	42	23134	14820	54586	19	13	24
<b>Impulsive</b>	47	8870	996	14369	33	25	50
<b>Slow</b>	17	22080	15358	30286	29	25	40
<b>Fast</b>	12	10695	6431	14250	23	17	24
<b>Total</b>	118	14595	966	54586	25	13	50

***Wholist-analytic Style Groups***

Wholist-analytic ratios were cut into 3 equal groups and participants labelled as wholist, intermediate or analytic. The cut points for groups are shown in Table 12.2; they were similar to the recommended cut points provided in the CSA manual, see guidelines provided for reference.

**Table 12.2: Classification of wholist-analytic style ratio**

Classification labels	CSA					CSA Guidelines
	N	Mean	Min	Max	Ratio	Ratio
<b>Wholist</b>	74	0.85	0.62	0.98	< 0.99	≤ 1.02
<b>Intermediate</b>	71	1.11	0.99	1.23	≥0.99 - 1.23	1.03 - 1.35
<b>Analytic</b>	72	1.50	1.24	2.29	≥ 1.24	≥ 1.36
<b>Total</b>	217	1.15	0.62	2.29		

There was no significant difference in mean age between the groups ( $F = .277$ ,  $df = 2,214$ ,  $p = .758$ , means between 21.12 and 21.72 years) and no significant difference in sex ( $\chi^2 = 1.576$ ,  $df = 2$ ,  $p = .455$ ). Scores were approximately normally distributed ( $Z = 1.247$ ,  $p = .089$ )

A chi-squared test compared the number of wholists, intermediates and analytics that were categorized as reflective, impulsive, slow or fast against with the number expected by chance.

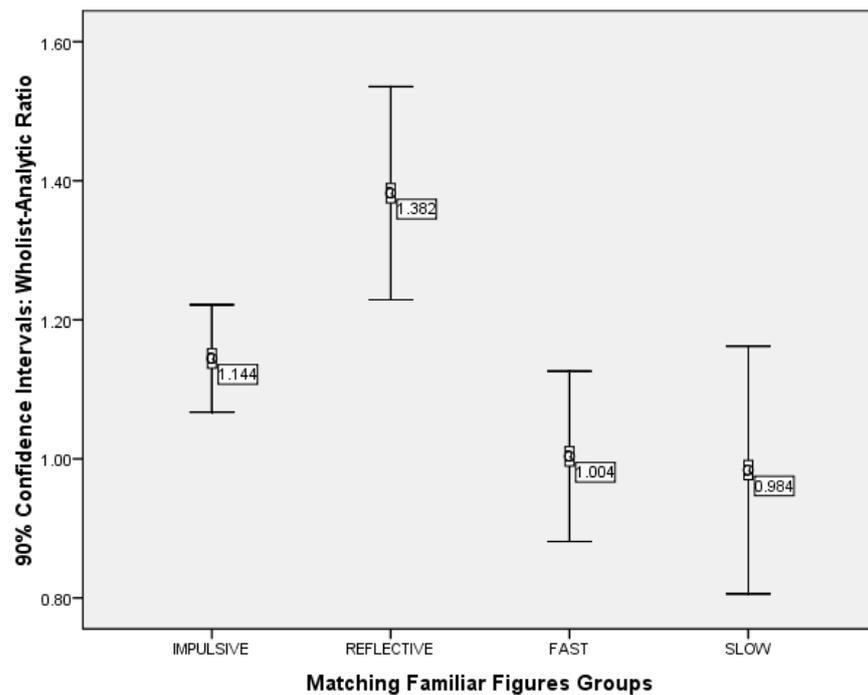
**Table 12.3: Observed and Expected counts for wholist-analytic style by reflective-impulsive style.**

Style	Observed N (Expected N)			
	Wholist	Intermediate	Analytic	Total
<b>Impulsive</b>	6 (8.1)	17 (12.2)*	9 (11.7)	32
<b>Reflective</b>	3 (5.8)*	5 (8.7)*	15 (8.4)*	23
<b>Fast</b>	6 (2.8)*	4 (4.2)	1 (4)*	11
<b>Slow</b>	3 (1.3)*	1 (1.9)	1 (1.8)	5
<b>Total</b>	18	27	26	71

The observed count significantly deviated from the expected count ( $\chi^2 = 20.369$ ,  $df = 6$ ,  $p = .002$ ). 65% of participants with a reflective style also had an analytic style, which is much higher than the expected 37%. 53% of the participants with an impulsive style also had an intermediate style, which is also higher than the expected 38%

The chi-squared test suggests that there are more ‘fast and accurate’ responders and ‘slow and inaccurate’ responders in the wholist group than would be expected by chance, there are more impulsive responders in the intermediate group and more reflective responders in the analytic group.

This was confirmed by a one-way analysis of variance, which demonstrated a significant effect of reflective-impulsive style (reflective, impulsive, fast, slow) on the wholist-analytic ratio ( $F = 5.010$ ,  $df 3, 67$ ,  $p = .003$ ). Post hoc tests revealed that the reflective group were significantly more analytic than the impulsive group ( $p = .047$ ) and the fast group ( $p = .011$ ) and approaching significance for the slow group ( $p = 0.79$ ). Figure 12.3 demonstrates clearly that based on 90% confidence intervals there is no overlap between the expected population means of reflectives and impulsives.



**Figure 12.3: Means and 90% confidence intervals for wholist-analytic ratio by reflective-impulsive style categories**

### **12.3.2 Wholist-analytic style and analytic-intuitive style**

A Pearson correlation revealed no significant relationship between wholist-analytic style and analytic-intuitive style ( $r = .114$ ,  $p = .088$ ). It is unlikely that the low correlation is an artefact of the measures, as was suggested above for the reflective-style scale, since both measures do represent a true bipolar continuum. However, in the interests of thoroughness a chi-squared test was also performed to cross tabulate the wholist-analytic style labels with the analytic-intuitive style labels. The relationship between the style labels did not significantly deviate from chance ( $\chi^2 = .267$ ,  $df = 2$ ,  $p = .865$ ).

### **12.3.3 Reflective-impulsive style and analytic-intuitive style**

A Pearson correlation revealed no significant relationship between wholist-analytic style and analytic-intuitive style ( $r = -.094$ ,  $p = .288$ ). A chi-squared test was performed to cross tabulate the reflective-impulsive style labels with the analytic-intuitive style labels. The relationship between the style labels did not significantly deviate from chance ( $\chi^2 = 1.958$ ,  $df = 3$ ,  $p = .561$ ).

### **12.3.4 Wholist-analytic style and convergent-divergent style**

A Pearson correlation revealed a significant relationship between wholist-analytic style and convergent-divergent style ( $r = -.353$ ,  $p = .011$ ). Convergent individuals were more analytic and wholists were more divergent. No statistics are available comparing performance on convergent-divergent style with reflective-impulsive style and analytic-intuitive style.

## 12.4 Discussion

This study was designed to replicate the findings of the previous correlation study by using the traditional methods of assessing wholist-analytic style and reflective-impulsive style to allow direct comparisons to be made with the styles literature. The CSA was used instead of the WAS analyses as the basis of the wholist-analytic ratio; and the MFFT was used instead of the speed and accuracy data derived from the wholist-analytic trials.

A weak relationship was found between reflective-impulsive style and wholist-analytic style, which replicated the findings in Chapter eleven. The weak nature of the relationship appears to contradict the notion that the wholist-analytic ratio is confounded by reflective-impulsive style, however, the low correlations are likely to be an artefact of using a continuous reflective-impulsive scale, which will inevitably include slow and fast participants who are not characterised by a reflective or impulsive approach. A one-way ANOVA confirmed that reflective groups produced more analytic ratios.

Reflective-impulsive style did not correlate with analytic-intuitive style, which is not consistent with the findings in the previous chapter. A chi squared test confirmed the absence of a relationship which means the lack of correlation was not because of the inclusion of slow and fast participants in the continuous reflective-impulsive scale. The lack of correlation with the MFFT could be a result of the MFFT being sensitive to analytic-global differences.

Convergent-divergent style correlated with wholist-analytic style, which again contradicts the findings in the previous chapter. In this case the equivocal correlational data may be a result of a slight change in the administration of the convergent-divergent tests; in the previous chapter the presentation of the non-verbal convergent test, the verbal convergent test and the divergent test was

counterbalanced and each test was given a 7.5 minute time limit. However in this chapter, the non-verbal and the verbal convergent test were combined as one test and given a 15 minute time limit and was counterbalanced with the divergent test which was also given a 15 minute limit.

Therefore, the time limit apportioned to the convergent tests remained constant and was consistent with the MENSA guidelines but the time limit for the divergent test doubled. The increased time limit for the divergent, object uses test was more in keeping with Hudson's (1967) recommendations. The test-retest reliability of the convergent-divergent tests used in this chapter was excellent producing a coefficient of  $r = 0.74$ .

## **Section IV.**

### **Discussion**

## **Chapter 13:**

### **Discussion**

## **Chapter 13: Discussion**

### **13.1 Chapter introduction**

This thesis questioned the validity of the wholist-analytic style ratio to measure the relative ability to use part or whole processing strategies. Two overarching hypotheses were presented which related to the nature of the processing being measured by the wholist-analytic ratio: the first hypothesised that the wholist-analytic ratio is confounded with a sensitivity to reflective-impulsive style; and the second hypothesised an asymmetry in the ratio which has resulted in wholists, but not the analytics, being judged by their relative ability to part or whole process. The rationale for each hypothesis is summarised below and the findings will be discussed in 13.2 and 13.3, respectively.

It was suggested that the wholist-analytic ratio is sensitive to differences in reflective-impulsive style and that high, more analytic ratios may be indicative of an individual's tendency to take a reflective approach in uncertain situations rather than indicating their relative ability to use part or whole processing. The sensitivity to measures of reflective-impulsive style was hypothesised to be a result of a limitation in the methodology employed by the CSA (Riding, 1991), which failed to counterbalance the presentation of the matching figure and embedded figures tasks. The lack of counterbalancing, coupled with the fact that the ratio method compared the median speed to complete the first subtest with the median speed to complete the second subtest, meant that individuals were labelled as wholists or analytics based on the hesitancy of their approach to early test items regardless of whether the test items were wholist or analytic in nature, and this is the theory of diminished reflection.

It was further hypothesised that there is an asymmetry in the nature of part and whole processing being compared between wholists and analytics. The wholist-analytic

ratio purports to measure relative ability use part or whole processing with analytics being better at part processing than whole processing because part processing is their preferred style; and wholists being better at whole processing than part processing because whole processing is their preferred style. It was hypothesised that whilst wholists were being labelled based on their relative ability to whole or part process, analytics were being labelled based on the efficacy of a part processing style to process tasks which are congruent on incongruent to a part processing strategy. This asymmetry is hypothesised to be the result of the matching figures tasks allowing respondents a strategy choice between part and whole processing but the embedded tasks force the use of a part processing strategy. When given an option part processors will habitually choose part processing and will therefore chose to employ part processing to complete the matching figures task and the embedded figures task, whereas, the whole processors will choose whole processing to complete the matching figures tasks but will be forced to use part processing for the embedded figures tasks. Therefore, the part processors relative ability to part process and whole process is not being assessed; the only thing that is being demonstrated is that they have a preferred part processing strategy.

This thesis has also offered an explanation for the low reliability that has been reported in the literature. It was hypothesised that the theory of diminished reflection can account for the lack of temporal stability, which has been widely demonstrated (Peterson et al., 2003; Parkinson, et al., 2004; Rezaei and Katz, 2004; Cook, 2008). The effect of diminished reflection will be much reduced at subsequent test sessions because the second test session is not characterised by uncertainty. It is the uncertainty that is inherent in the first session, which induces reflection over responses to ensure accuracy. The findings in relation to this hypothesis are discussed in 14.4.

The final strand to the research addressed the unidimensional perspective of style; the conception of the wholist-analytic dimension was based on the notion that many

of the analytic-global constructs in the literature were merely describing different aspects of one super-ordinate wholist-analytic dimension, which is characterised by a tendency towards synthesis or differentiation in organisation and processing information. Attempts to demonstrate the hypothesised relationship between subordinate style constructs in the wholist-analytic family have met with limited success which has led to a growing disillusionment with the unitary perspective in favour of a multidimensional perspective (Hodgkinson and Sadler-Smith, 2003; Peterson and Deary, 2006). It is entirely likely, however, that the dearth of evidence in support of a relationship between the global-analytic styles is a result of the inherent methodological problems, which pervade many measures of style. In line with Riding's (2005) recommendations, the current thesis compares performance on four measures of style to assess the relationship between them. Care was taken to use reliable and valid measures of style and extensive periods of construction, development and validation were undertaken for each measure in the pursuit of psychometrically sound instruments. The findings relating to the unidimensional perspective of style are discussed in 13.5.

### **13.2 The theory of diminished reflection: effects on the validity of the wholist-analytic ratio method**

When administering any psychological test it is best practice to control for the confounding influence of order effects by counterbalancing the presentation of items or tasks. This reduces unwanted variables such as boredom or practice effects from influencing the outcome of the test. This need for counterbalancing is even more vital in the context of the CSA (Riding, 1991) because it employs a ratio method that compares performance on one subtest with performance on another subtest. Therefore, any order effect which influences a respondent to begin slowly in the first subtest and then speed up as they progress through the second subtest will directly effect the ratio of response times to the first and second subtest.

To illustrate this problem two versions of the WAS analysis were used to demonstrate the influence of order effects on the wholist-analytic ratio. The WAS analyses were based on the wholist-analytic subtests of the CSA and were identical in every respect except that the WAS-WA presented the matching figure subtest first and the embedded subtest second and the WAS-AW presented the embedded figure subtest first followed by the matching figure subtest.

Both versions of the WAS analysis calculate the wholist-analytic ratio using the same method as the CSA, by working out the ratio of the median latency on the matching figures test to the median latency on the embedded figures test. In each case a ratio of less than one would indicate that an individual took relatively longer to complete the embedded figure items and a ratio of more than one would indicate that they took relatively longer on the matching figure items.

It was hypothesised that the presence of order effects would lead to the WAS-WA producing a significantly higher mean ratio than the WAS-AW. This hypothesis was supported; the WAS-WA, which presented the matching figure subtest first, produced much higher ratios and the difference represented a large effect size. Almost 70% of the people, who completed one of the versions of the WAS analysis, took longer to respond to the first subtest than the second subtest. When generalised to the population it is predicted that the WAS-WA would produce mean ratios between 1.12 and 1.35, and across three samples tested here the means were between 1.19 and 1.24, see Chapter six and nine and Davies and Graff (2006). These data are comparable to the normative data provided by Riding (1991; 1998; 2005) suggesting mean ratios in the region of 1.10-1.25.

Riding's standardised data give the impression that the population are slightly skewed towards more analytic styles; however, the expected population mean ratio based on the WAS-AW was 0.92 and 1.06, and the sample mean was 0.99 which is

near the perfect theoretical mean of one. This suggests that rather than being skewed towards being more analytic the population follows a, perhaps unsurprising, trend to being more hesitant during early test items.

This robust order effect had an unanticipated impact on the discriminatory power of the WAS analyses and by extension would be expected to have the same effect on the discriminatory power of the CSA. As hypothesised the inadequate counterbalancing of the matching figure and embedded figure subtests, coupled with the fact that the ratio method compared the median speed to complete the first subtest with the median speed to complete the second subtest, meant that individuals were labelled as wholists or analytics based on the hesitancy of their approach to early test items rather than on their relative ability to part or whole process. However, an unanticipated effect, although in hindsight a result that should have been predicted, was the impact this would have on the discriminatory power of each subtest.

The findings demonstrated that the ratios produced by the wholists and the analytics significantly differed in the first and second test quarter, which constitutes the first subtest; but not in the third and fourth test quarter, which constitutes the second subtest; the difference in processing speeds diminished as the test progressed and this effect was replicated see Chapter six and Chapter nine.

Therefore, the first subtest differentiated between wholist and analytic styles but the second subtest did not. When the matching figures subtest was presented first, it was the speed of processing the matching figures not the embedded figures that distinguished between wholists and analytics; analytics were significantly slower than wholists when processing matching figure tasks but not significantly different when processing embedded figure tasks.

Similarly, when the embedded figures subtest was presented first, it was the speed of processing the embedded figures not the matching figures that distinguished between

wholists and analytics; wholists were significantly slower than analytics when processing embedded figure tasks but not significantly different when processing matching figure tasks. The implication is that whilst ratios have been based on relative ability to process the first or second subtest; the greatest variance and therefore the discriminatory power lays only in one subtest, that is whichever subtest is presented first.

In the context of the CSA, this means that the discriminating factor between the wholists and the analytics is their speed of processing the matching figures subtest. This undermines the major strength of the wholist-analytic ratio, which is purported to be its bipolar basis (Riding and Cheema, 1991; Riding, 1998; 2005) Riding argued that the cognitive styles analysis was a superior measure of style because it “positively assesses both ends of the style dimensions”, he goes on to state that this is very important “since otherwise it could be objected that the assessment is simply of ability and not of style.” (Riding, 1998; 2005, p. 5).

### **13.2.1 Interaction between order effects and reflective-impulsive style**

Importantly, the order effects demonstrated here do not affect all respondents equally; the effects were hypothesised to influence reflective participants to a greater extent than impulsive participants because the tendency to begin slowly during early test items is a characteristic of individuals with a reflective style. Reflective individuals were predicted to take longer over their responses to ensure accuracy, whereas an impulsive individual would be focused on speed rather than accuracy (Kagan et al., 1964). Reflective behaviour occurs in situations of uncertainty, therefore, it was expected to be at its peak at the beginning of the test; and then as the reflective individuals assessed the trial items to be consistently easy, their reflection time would diminish and their response times decrease.

This hypothesis that reflective and impulsive individuals would be differentially effected by the order of presentation was supported; the reflective group had significantly more analytic ratios than the impulsive group when they completed the matching figures subtest first, indicating that they were slower at the first subtest than the second subtest.

Riding's unitary perspective of wholist-analytic style could account for this finding (Riding, 1991). It could be argued that the reflective individuals would be expected to be more analytic because the reflective-impulsive construct is part of the wholist-analytic family and reflective style is at the analytic pole of the wholist-analytic dimension. Therefore, the occurrence of higher ratios is because they have a preferred part processing style indicative of an analytic style and not because they are just slower at early test items. From this perspective the wholist-analytic ratio is valid and the finding that reflective individuals are also analytic is merely support for the unidimensional view of wholist-analytic style.

However, further findings convincingly demonstrate that reflection has a direct influence on the wholist-analytic ratio and that the tendency of analytics to be more reflective is not just one of association. The influence of reflective style on the wholist-analytic ratio was effectively demonstrated by manipulating the order in which the subtests were presented by administering either the WAS-WA or the WAS-AW versions of the WAS analysis.

If the tendency of reflectives to achieve more analytic ratios was just a matter of association and not a result of reflective style interacting with order effects then reflectives should have more analytic ratios when they complete the WAS-WA and when they complete the WAS-AW.

The findings confirmed that when the matching figures test was presented first, the reflective group were relatively slower to process the matching figure trials in

comparison to the embedded figure trials which led to them being classified as 'Analytics', producing a mean ratio of 1.31. However, when the order of the subtests was reversed and the embedded figure trials were presented first, the reflective group were relatively slower to process the embedded figure trials in comparison to the matching figure trials which led to them being classified as 'Wholist', producing a mean of 0.96.

Since the only difference between the WAS-AW and the WAS-WA is the order of presentation, this is strong evidence that reflective participants achieve analytic ratios because of their reflective behaviour and not just because part processors who achieve analytic ratios are expected to also have a reflective style.

Further, evidence to support this comes from the absence of order effects on the impulsive participants. Presentation order had little impact on the impulsive group, they produced intermediate level ratios regardless of the order in which the subtests were presented, suggesting that their processing speed was relatively uniform across the two subtests; although they did obey the general population trend to produce higher ratios in the WAS-WA and lower in the WAS-AW; the impulsive group mean ratios were 1.16 in the WAS-WA and 1.03 in the WAS-AW. This presents another unforeseen problem with the discriminatory power of the wholist-analytic ratio; not only does the power lay mainly in the first subtest but the source of the variation may rest with a subsection of the participants, that is, those with a reflective style.

The findings support the theory of diminished reflection, which suggests that the wholist-analytic ratio is sensitive to reflective-impulsive style and therefore raises doubts over the validity of the wholist-analytic dimension. If the ratio is measuring reflective-impulsive style then this must be reconciled with the large body of research pertaining to the validity of wholist-analytic dimension.

Chapter two evaluated a collection of studies, which effectively demonstrated the power of the CSA to discriminate between the performance of wholists and analytics in open ended or closed end learning situations (Roberts, 2006); and to discriminate between their instructional preferences and media preferences which related to collaborative learning (Sadler-Smith and Riding, 1999) and to discriminate differences in task and non task related, alpha suppression in EEG studies (Riding et al., 1997; Glass and Riding, 1999). Further, appendix 1 describes a number of studies linking differences in interpersonal and social functioning and preferences with wholists and analytics (Riding and Craig, 1998; 1999; Riding, 1991).

The studies which more directly assessed the power of the CSA to discriminate between the wholists and analytics need for structure based on their relative ability to whole and part process were more equivocal, demonstrating very little support for the prediction that wholists need help imposing structure in unstructured situations or that they benefit from such help. There was no consistent evidence linking wholist-analytic style with learning performance when the structure of learning material has been manipulated; Riding and Sadler-Smith (1992) found no significant interaction effect of structure and wholist-analytic style when manipulating either small step versus large step or presence or absence of an advance organiser. Riding and Douglas (1993) did find that the presence of a title benefited wholists rather than analytics but this was not replicated by Riding and Al-Sanabani (1998) who found no significant interaction between the use of sections with headings and wholist-analytic style.

Riding and Sadler-Smith (1992) found evidence to suggest that complimentary styles benefited from a small step structure but unitary styles did not, but again this was not replicated by Riding and Al-Sanabani (1998) who found no interaction between wholist-analytic style, verbal-imager style and the use of sections with headings.

In addition, the effect of style on performance in relatively more structured subjects such as science has been equivocal (Newton et al., 1995; Riding and Agrell, 1997; Riding and Grimley, 1999; Riding and Pearson, 1994; Riding et al., 2003) and the one study which directly assessed the power of the wholist-analytic dimension to predict local and global processing, found no association between a tendency to process globally or locally and wholist-analytic style (Peterson and Deary, 2006).

It was concluded that whilst there was evidence for the subordinate style predictions, there was limited evidence for super-ordinate predictions. Subordinate style predictions are those that predict behaviour or characteristics, which would be associated with any of the style constructs within the wholist-analytic family. Super-ordinate predictions would be those that validate the claim that the wholist-analytic ratio is successfully measuring differences in part-whole processing.

The difficulty with validating global-analytic style measures is that, given the unidimensional perspective, any of the global-analytic styles would be predictive of similar preferences and differences in social functioning. This means that if the wholist-analytic ratio is sensitive to differences in reflective-impulsive style, then this could account for the learning and social preferences which have been linked to the wholist-analytic dimension. It also follows that the influence of reflective-impulsive style may be confounding the studies that relate to super-ordinate predictions, masking the effects of part and whole processing preferences. These two explanations are not mutually exclusive.

The effect of reflective style is clear and the influence of diminished reflection on the wholist-analytic ratio reduces the validity of the current ratio method of measuring wholist-analytic style. However, the findings lead to a number of positive conclusions, firstly, the effect of diminished reflection can be easily rectified with adequate counterbalancing and this and other recommendations will be discussed in 14.7; secondly, the findings demonstrate the presence of a part-whole processing

difference which until now had just been assumed but not demonstrated, this and other evidence for the presence of part-whole processing will be discussed in 13.3; thirdly, the theory of diminished reflection offers a much needed explanation for the low temporal stability which characterises the wholist-analytic ratio, this too will be improved once the CSA has been adequately counterbalanced and this will be discussed in 13.4; and, finally the evidence which links reflective style with part processing style by demonstrating the complimentary and conflicting effects of changing presentation order provides some support for the unidimensional perspective of style and this will be discussed along with the correlational and factorial analyses data in 13.5

### **13.3 The wholist-analytic ratio: A measure of part versus whole processing**

Riding (2005, p. 6) stated “The most important feature of a test is its *construct validity* - if there is no evidence that it assesses what it purports to measure then it is of no use.” The wholist-analytic style dimension purports to measure differences in relative ability to part and whole process. It determines “whether an individual tends to *organise* information in wholes or parts.” (Riding, 2005, p. 1) and “the relevant underlying abilities are differentiation and synthesis” (Riding, 2005, p. 3).

Chapter two demonstrated that there is insufficient evidence to validate the notion that the wholist-analytic dimension is a measure of relative ability to part and whole process. Chapters six and nine demonstrated that the wholist-analytic ratio is confounded by measures of reflective-impulsive style and these style differences can offer an alternative explanation for the power of the CSA to discriminate between individual differences in social and interpersonal preferences and the EEG differences that have been documented in the literature.

Until now there has been no clear evidence that the wholist-analytic ratio is actually measuring part-whole processing differences, however, two sources of evidence have emerged during the course of the present research, which provide evidence that the wholist-analytic ratio is measuring part-whole processing differences thereby providing partial support for the construct validity of the measure.

The first strand of evidence comes from the conflicting effects of concomitant part-whole processing and reflective-impulsive styles on the wholist-analytic ratio, which were demonstrated when the presentation order of the matching figure and embedded figure subtests was reversed.

### **13.3.1 Style conflicts: Reflective-impulsive approach and part-whole processing**

It was demonstrated in Chapter six and nine that the wholist-analytic ratio is confounded by reflective style, but is the ratio also measuring differences in part-whole processing style? Examining the combined effects of reflective-impulsive style and part-whole processing when the presentation order of the subtests was manipulated can reveal the answer to this question. If the wholist-analytic ratio was measuring reflective-impulsive differences as a result of the lack of counterbalancing but was not measuring part-whole processing differences then two predictions should have been fulfilled; reflectives should have produced significantly higher wholist-analytic ratios than impulsives when the matching figures subtest was presented first and significantly lower ratios than impulsives when the embedded figures subtest was presented first. The findings did demonstrate that reflectives produced significantly higher ratios than impulsives when the matching figure subtest was presented first but the reflectives did not produce significantly lower ratios than impulsives when the embedded figures subtest was presented first.

These findings demonstrate the presence of part-whole processing differences in a way than has not been previously been achieved in the literature. The evidence suggests that the inflated ratios achieved by analytics and reflectives on the WAS-WA was a result of complimentary part-whole plus reflective-impulsive style effects whereas the lack of significant difference between the reflectives and impulsives on the WAS-AW was the result of conflicting part-whole versus reflective-impulsive style effects; the evidence is outlined below.

The inflated wholist-analytic ratio, which was produced by the reflective group when the matching figures test was presented first, was hypothesised to be a result of their reflective approach to the early matching figure test items but also to be an effect of a part processing preference which made them faster at processing embedded figure items and slower at processing matching figure items. Since the unidimensional theory of style suggests that analytics are also more likely to have a reflective style it was predicted that their concomitant reflective and part processing styles would work in the same direction, that is both styles would lead to the individual being slower in the first, matching figures subtest. Partial support for this comes from the finding that reflective individuals did produce significantly higher ratios than impulsive individuals on the WAS-WA, with means of 1.31 for reflectives and 1.16 for impulsives, indicating that they had an analytic style. However, only by considering the opposite assumption can the hypothesis be tested convincingly.

When faced with the WAS-AW version of the WAS analysis which reverses the order of the subtests; an analytic individual with a part processing preference and a reflective approach to early test items would be faced with conflicting style effects. The reflective style approach would create a tendency to be slower at the embedded figure items at the beginning of the test and speed up through the matching figure items towards the end of the test. The part processing preference would create an opposing tendency to be faster at the embedded figure items in comparison to the matching figure items. If the wholist-analytic ratio was sensitive to both styles then

300

the reflective style should have been cancelled out by an opposite effect of part processing style; this hypothesis was supported, the reflective individuals group mean ratio of 0.96 was not significantly different to the impulsive groups mean ratio of 1.03.

Therefore, the influence of reflective style on the wholist-analytic ratio when the embedded figure task was presented first was not apparent. The two versions of the WAS analysis which were used to manipulate subtest order were identical in every way except for the order of the subtest; therefore the only explanation for the reduced impact of reflective style when the embedded figure subtest was presented first was that concomitant differences in part-whole processing differences were working in against the reflective style differences to cancel out the effects. This provides support for the construct validity of the wholist-analytic dimension whilst raising doubts over the ratio method currently used to measure it. The efficacy of the matching figures tasks and the embedded figures tasks to discriminate between part and whole processing preferences is hampered by of the lack of counterbalancing which confounds the ratio with differences in reflective-impulsive style.

The second strand of evidence providing support for the efficacy of the wholist-analytic ratio to differentiate between part and whole processing preferences stems from the experimental manipulation of the number of simple shapes in the complex geometric stimuli in the wholist-analytic subtests, which has provided evidence that the matching figure tasks and the embedded figures tasks do discriminate between part and whole processing preferences but not in the way Riding (1991) intended.

### **13.3.2 A part-whole processing asymmetry**

Riding stated that wholist-analytic style is an “ability difference, rather than a preference as such” (Riding, 2005, p. 5). The suggestions being that individuals have

a preference for which style they employ, either part or whole processing, and will perform relatively better when using their preferred style than when using an alternate style. Riding argues that an individual with an analytic style is better, i.e. quicker; at completing the embedded figures test because they are better when using their preferred part processing strategy and, that an individual with a wholist style is better, i.e. quicker: at completing the matching figures tasks because they are using their preferred whole processing strategy. The implication is that the embedded figures task requires part processing and the matching figures task requires whole processing, however, this is not strictly the case.

This thesis hypothesised that the matching figures test could be completed using a part or whole processing style and therefore part processors would choose to part process matching figures tasks and whole processors would choose to use whole processing. It was further hypothesised that the embedded figures task could only be completed using a part processing strategy so part processors would use their preferred processing strategy and whole processors would be forced to use a strategy which wasn't their preferential method of processing. These hypotheses were supported and the effects replicated (see chapter six and nine), the asymmetry was exposed through the manipulation of complex figural stimuli into geometric figures made up of five simple shapes or geometric figures made up of three simple shapes.

It was theorised that all participants were likely to take a little longer to process the five part figures because they were more complex and therefore more difficult; however, those people employing a part processing strategy were expected to be slowed down significantly more than those employing a whole processing strategy because each additional part of the whole would increase the processing time proportionately for part processors but not for whole processors.

Two ratios were calculated comparing the speed of processing the three part figures to the speed of processing the five part figures; one ratio was based on the matching

figures latencies and the other on the embedded figure latencies. The matching figures ratio was expected to differentiate between those who had chosen a part processing strategy and those who had chosen a whole processing strategy; this ratio was called the part-whole processing ratio. The embedded figure ratio was not expected to differentiate between part and whole processors because everyone should have been forced to employ part processing to complete the tasks.

It was found that analytics and reflectives had lower part-whole processing ratios than wholists and impulsives, respectively. This supported the hypotheses that analytics and reflective individuals employed part processing to complete the matching figures tasks whereas; wholists and impulsives employed whole processing.

The embedded figure ratio did not differentiate between wholists and analytics or between reflectives and impulsive; this supports the hypotheses that reflectives and impulsives, and, analytics and wholists, employed part processing for the embedded figures test.

The implications of these findings are two fold; firstly, they demonstrate that when faced with a choice of processing strategy, analytics and reflectives choose part processing and wholists and impulsives choose whole processing. This is support for the construct validity of the wholist-analytic dimension suggesting that analytics and wholists do have a preferred processing strategy and it is partial support for the unidimensional view because reflectives and impulsives share the preference for part and whole processing. However, the second implication casts doubt on the validity of the wholist-analytic ratio method to capture symmetrical differences in part-whole processing.

The findings supported the hypotheses that part processors employed part processing for both tasks and whole processors employed whole processing for the matching

figures tasks and were forced to choose part processing for the embedded figures tasks. This means that the wholists were judged by their relative ability to employ their preferred and non-preferred processing strategy, which is consistent with Ridings notion that the ratio measures relative abilities to part and whole process. However, analytics were judged on the efficacy of a part processing approach to tackle tasks that are either a match or a mismatch for a part processing strategy. This is inconsistent with the notion that the ratio method measures relative abilities to whole and part process. This creates an asymmetry in the basis of the wholist-analytic ratio which undermines its validity but the presence of the asymmetry itself confirms that wholists and analytics have whole and part processing preferences. Therefore, the findings support the validity of the wholist-analytic dimension but not the method of measuring it.

#### **13.4 The reliability of the wholist-analytic dimension**

The wholist-analytic dimension has been reported to have low temporal reliability (Peterson et al., 2003; Rezaei and Katz, 2004; Parkinson et al., 2004; Cook, 2008).

Riding has been critical of such reports and has emphasised the methodological shortcomings of the reported reliability correlations. Riding argued that Peterson et al.,'s (2003) test-retest interval was too short and therefore not a fair test of reliability; and recommended test-retest intervals of at least one year as an appropriate test of temporal reliability. It has also been argued that Peterson et al. (2003) used a modified form of the CSA and therefore, the reported test-retest correlations do not reflect the reliability of the CSA (Riding, 2003; Redmond, Parkinson and Mullally, 2007). However, Cook (2008) and Parkinson et al., (2004) employed test-retest intervals of eighteen months and twenty-three months, respectively, using the unmodified CSA and reported similarly low correlations,

which were consistent with test-retest coefficients produced over shorter intervals and with Peterson et al's (2003) replica form.

Until now, no explanation has been offered to account for the low temporal reliability of the wholist-analytic dimension. Riding has considered the possibility that there may be a systematic difference leading to low temporal reliability posing the question "if test results do change, is there a systematic pattern to the shift rather than just a random change, and what does this indicate?" (Riding, 2005, p. 13). The theory of diminished reflection can provide a much-needed explanation for the low temporal reliability that is characteristic of the wholist-analytic dimension.

#### **13.4.1 Diminished reflection across test sessions**

Reflective characteristics occur in situations of uncertainty, the act of reflection is focussed on achieving accuracy of the first response and the uncertainty relates to whether accuracy can be achieved or how easily accuracy can be achieved. Therefore, the first time a reflective individual approaches the wholist-analytic subtests; they will proceed with caution through the early test items and speed up as they progress through the test. The diminished reflection represents a change in the degree of uncertainty, which is inherent in the test situation. At the start of the test there is uncertainty about the difficulty level and likelihood of accuracy from trial to trial but over the course of the test it becomes apparent that the tasks are consistently simple and as uncertainty changes to certainty, reflection diminishes.

When the same individual is required to complete the wholist-analytic subtests for a second time, the uncertainty, which characterised the first test session, will be considerably reduced. Analytics will produce lower ratios at the retest session because the ratio is no longer being inflated by concomitant differences in reflective style.

The findings supported this hypothesis demonstrating that when the matching figures task was presented first, the analytics did produce significantly lower ratios but the source of the instability between test and re-test was not limited to the analytic individuals. The test-retest reliability of the WAS-WA was a moderate  $r = 0.4$ , but when the test-retest coefficients were examined by style group it was found that the analytics and the intermediates were the source of instability producing correlations of  $r = -.1$  and  $0.1$ , but the wholists produced a satisfactory reliability correlation of  $r = 0.8$ .

The effect of diminished reflection was further demonstrated by its affect on the wholist-analytic ratio when the subtest order is reversed. When the embedded figures subtest was presented first, the reflective, part processors were inappropriately labelled as wholists because of the effect of reflective style and subtest order. At the second test session when the effect of reflective style had diminished, the reflective, part processors who had been previously labelled as wholists produced the highest mean ratio and were relabelled more appropriately as analytics.

This is evidenced by the instability of the WAS-AW producing a negative test-retest correlation of  $- 0.2$ . All the style groups were unstable across test sessions; those labelled analytics and intermediates at the first test session were as likely to be wholists or intermediates at the second test session. The wholists either remained wholist or became high analytics; this means that some of the participants were genuinely whole processors and therefore remained wholist across both sessions but a high proportion of those labelled wholist at the first session were merely reflective, part processors whose reflective style made them process the first, embedded figures test more slowly. At the second subtest the diminished affect of reflection meant that the part processors swung from being labelled as wholists to being labelled as analytics.

The difference in the temporal stability of the WAS-AW and the WAS-WA can only reasonably be attributed to the interaction between diminished reflective style and order effects present because of the lack of counterbalancing.

#### **13.4.2 Explaining the variability in test-retest correlations in modified forms of the wholist-analytic measure**

The theory of diminished reflection has the explanatory power to account for the low temporal reliability of unmodified forms of the wholist-analytic measure and to explain improvements, which have been achieved in the literature when the methodology of the wholist-analytic measure has been manipulated. The effect of diminished reflection predicts low test-retest reliability in any measure of wholist-analytic style, which relies on a ratio method and fails to adequately counterbalance the completion of the matching figures and embedded figures subtests. This is because the first test session will measure the combined effects of reflective-impulsive style and part-whole processing style and the second test session will measure the effects of part-whole processing style without the influence of reflective-impulsive style.

The theory of diminished reflection therefore, also predicts that any test that reduces the influence of reflective-impulsive style at the first test session will improve the test-retest correlations between session one and session two.

Unmodified forms of the wholist-analytic dimension have produced test-retest ratios between .30 and .045 (Parkinson et al., 2004, Rezaei and Katz, 2004; Cook, 2008) and Peterson et al.'s, (2003) replica and parallel forms of Riding's CSA (1991; 1998; 2005), which reproduce the CSA's test instructions, have produced similarly low correlations of 0.30 and 0.31, respectively.

The WAS analysis has made a number of revisions to the wholist-analytic subtests which were predicted to increase reliability and exceed the coefficients produced by unmodified forms of the CSA and the forms which preserve test instruction. The WAS analysis corrected a bias in Riding's (1991, 1998; 2005) CSA instructions which encouraged a cautious approach to the matching figure subtest but not to the embedded figure subtest; this bias was postulated to have encouraged greater reflection amongst reflective participants and therefore increased the effect of diminished reflection and decreased the reliability of the wholist-analytic dimension. The WAS analysis also introduced four practice items before each subtest with a similar aim of reducing uncertainty and the effects of reflection on the reliability of the wholist-analytic ratio.

The WAS analysis produced an improved test-retest correlation of 0.44 which exceeds the correlations typically reported in the literature (Peterson et al., 2003; Parkinson et al., 2004; Cook, 2008) but did not exceed the correlations produced by Rezaei and Katz (2004) when they employed unmodified forms of the CSA. The improvement in reliability of the WAS analysis has been attributed to its improved, more balanced test instructions and the inclusion of practice items which reduce the influence of reflective style. However, the temporal reliability was equivalent to but did not exceed Rezaei and Katz (2004) test-retest correlations; Two out of the three samples reported in Rezaei and Katz, (2004) study employed an unmodified form of the CSA which preserved the bias in test instruction so the fact that the WAS analysis did not improve on these correlations does limit the conclusions which can be drawn regarding the effectiveness of the improvements to the test instructions and inclusion of practice items. However, it is unclear whether Rezaei and Katz (2004) test-retest correlations are based on ratio scores or label classifications and the slightly increased coefficients may be a reflection of the use of labels as the basis for the calculation which has been shown to lead to an increase in the correlation (Peterson et al., 2003; Parkinson et al., 2004).

The temporal reliability of the WAS analysis was lower than Rezaei and Katz's (2004) correlation of 0.55 when test instructions were manipulated to produce a bias towards speed, and Peterson et al.'s (2003) extended version of the CSA, the C-CSA or the E-CSA (Peterson and Deary, 2006). Both of these studies have inadvertently reduced reflective tendencies at the first subtest and therefore improved the correlation between test and retest.

The bias created by Rezaei and Katz (2004) by encouraging overall speed of response is likely to have had the greatest influence on analytic participants, reducing their reflective tendencies. This is consistent with Nietfeld and Bosma (2003) who found that the greatest increase in speed was produced by reflectives when speed was emphasised.

Peterson et al. (2003) combined the replica and parallel version of the CSA to form the extended CSA, which has produced improved test-retest correlations of 0.53. The way in which the forms were combined are likely to account for the improvement; instead of adding the two groups of twenty matching figure items together from each test version to form the matching figure subtest and adding the two groups of twenty embedded figure items together to form the embedded figure subtest, Peterson et al. have merely bolted together the replica version to the parallel version. Participants are, therefore, presented with the first matching figures subtest followed by the first embedded figures test and then after a five minute interval they are presented with the second matching figures test followed by the second embedded figures test. The result is that the first two subtests are likely to be subject to the postulated effects of diminished reflection but the second set of subtests will be less affected because of a reduction in uncertainty. When the trial items are combined to produce the wholist-analytic ratio, the measure is less susceptible to the confounding effects of reflective style and therefore produces higher correlations at retest.

The final evidence in support of the theory that diminished reflection is the cause of the wholist-analytic ratio's lack of temporal reliability is provided by the detrimental effect that reversing the subtest presentation order had on the stability of the ratio. The conflict, which is created, between the concomitant styles of reflection and analysis when the subtest order is reversed leads the reflective individuals to oscillate from producing the lowest mean wholist ratio in the first test session to producing the highest mean analytic ratio at retest. This pendulum swing creates greater instability, which is apparent from the weak, negative test-retest correlation of  $-.20$ .

### **13.5 The unidimensional perspective: Is there a relationship between style labels in the wholist-analytic family?**

The unidimensional perspective of style predicts that relationships should exist between analytic-global constructs, which are thought to measure different aspects of the same dimension. To explore this, two studies were done to compare performance on wholist-analytic style, convergent-divergent style, reflective-impulsive style and analytic-intuitive style.

The first study employed the WAS analyses as the measures of wholist-analytic style, this measure was chosen instead of the CSA to allow an exploration of the effects of subtest presentation order on the relationship between the wholist-analytic ratio and similar style constructs and to allow an examination of the relationship between the new part-whole ratio and other related styles. Reflective-impulsive style was measured by calculating the median latency and the response accuracy across the eighty trials in the WAS analysis. Reflective-impulsive style is demonstrated to be stable across a variety of tasks (Nietfeld and Bosma, 2003) and this method controlled for the local and global nature of the tasks by calculating reflective-impulsive style across the matching figure and embedded figure tasks. This method

was chosen in light of the criticisms of the MFFT, which is the traditional method of assessing reflective-impulsive style; the MFFT is reported to be biased toward analytic processing (Zelniker and Jeffrey, 1979) and have low internal consistency (Buela-Casal et al., 2003). Convergent-divergent style was measured by the newly constructed and extensively developed and validated convergent and divergent thinking style tests. Finally, analytic-intuitive style was measured using the Cognitive Styles Index (CSI), a self-report instrument measuring a similar super-ordinate dimension of style. The CSI was chosen because it has demonstrated the best reliability and validity of any of the global-analytic measures (Allinson and Hayes, 1996, Coffield et al., 2004).

The second study was designed to replicate the findings of the previous correlation study by using the traditional methods of assessing wholist-analytic style and reflective-impulsive style to allow direct comparisons to be made with the styles literature. Therefore, in this study the CSA, the MFFT, the CSI and the convergent-divergent thinking test were employed to examine the relationship between wholist-analytic style, reflective-impulsive style, analytic-intuitive style and convergent-divergent style.

### **13.5.1 Wholist-analytic style and reflective-impulsive style**

A weak relationship was found between reflective-impulsive style and wholist-analytic style, this relationship was evident when the WAS analysis and the CSA were used as the basis of the wholist-analytic ratio. The weak nature of the relationship appears to contradict the notion that the wholist-analytic ratio is confounded by reflective-impulsive style, however, the low correlations are likely to be an artefact of using a continuous reflective-impulsive scale, which will inevitably include slow and fast participants who are not characterised by a reflective or

impulsive approach. The effect of reflective-impulsive style on the wholist-analytic ratio is more apparent when reflective-impulsive style is used as an independent factor and wholist-analytic style is the dependent variable. Reflective groups produced more analytic ratios, this effect was evident when the WAS analysis was used as the basis of the reflective style and analytic style categorisation and was replicated when the MFFT and the CSA was used as the basis of the categorisations. These findings demonstrated a link between wholist-analytic style and reflective-impulsive style, however, the findings raised two further questions:

Firstly, was the link between wholist-analytic style and reflective-impulsive style a real relationship or did it just reflect the sensitivity of the wholist-analytic ratio to reflective-impulsive style?

Secondly, the link between reflective style and analytic style is greater when the WAS analysis is used as the basis of wholist-analytic style. Ironically, this leads to the possibility that the WAS analysis is more sensitive to reflective-impulsive style than the CSA.

In answer to the first question, there was a relationship between the part-whole processing ratio and reflective-impulsive style suggesting that there is a genuine relationship between the part and whole preferences of analytics and wholists and their reflective-impulsive styles. Additionally, the conflict between reflective style and part processing or analytic style, which has been demonstrated when the order of the matching figure and embedded figure subtests is reversed, would only occur if part processors have a concomitant reflective style.

The second question brings into focus the effect of the increased complexity that was introduced to the WAS analysis by increasing the number of simple shapes which constitute the complex geometric stimuli in the wholist-analytic subtests. It is possible that the increased level of complexity has led to a more pronounced effect of

reflective style. If this is the case then the conclusions drawn from the WAS analysis would still inform the methodology of the CSA but smaller effect sizes may be expected in the context of the CSA.

### **13.5.2 Cognitive styles index (CSI) and reflective-impulsive style**

The only construct, which correlated with analytic-intuitive style, was reflective-impulsive style but the findings were equivocal; when the MFFT was used to measure reflective-impulsive style the CSI did not correlate but when reflective-impulsive style was calculated by the speed and accuracy of responses on the WAS analysis, a weak correlation was found. The findings suggest that the CSI is associated with differences in reflective-impulsive approaches and not to part-whole processing differences. The lack of correlation with the MFFT may be a result of the MFFT being sensitive to analytic-global differences.

The reflective-impulsive style measurement based on the WAS analysis was free from bias towards analytic or global processing and therefore demonstrated a relationship with the CSI. Analytic-intuitive style failed to correlate with wholist-analytic style when the CSA was used and when the WAS analysis was used as the basis of the ratio calculation; it also failed to correlate with the part-whole ratio and convergent-divergent style. However, when part-whole processing style, reflective-impulsive style, analytic-intuitive style and convergent-divergent style scores were entered into a principle component analysis; two factors were extracted and analytic-intuitive style loaded moderately on the first factor, with reflective-impulsive style and part-whole processing style loading highly on the same factor.

### **13.5.3 Convergent-divergent Style and Wholist-analytic style**

The only construct that correlated with convergent-divergent style was wholist-analytic style and the findings were equivocal. Convergent-divergent style did not correlate with wholist-analytic style when the WAS analysis was used but it did correlate when the CSA was used. In this case the equivocal correlational data may be a result of a slight difference in the administration of the convergent-divergent tests; in Chapter eleven the presentation of the non-verbal convergent test, the verbal convergent test and the divergent test was counterbalanced and each test was given a 7.5 minute time limit. However in Chapter twelve, the non-verbal and the verbal convergent test were combined as one test and given a 15 minute time limit and was counterbalanced with the divergent test which was also given a 15 minute limit.

Therefore, the time limit apportioned to the convergent tests remained constant and was consistent with the MENSA guidelines but the time limit for the divergent test doubled. The increased time limit for the divergent, object uses test was more in keeping with Hudson's (1967) recommendations. The test-retest reliability of the convergent-divergent tests using the methodology employed in Chapter twelve was very good.

Convergent-divergent style did not correlate with reflective impulsive style, part-whole processing style, wholist-analytic style or analytic intuitive style when the 7.5 minutes methodology was employed; and in the principle component analysis, convergent-divergent style did not load on factor one with reflective-impulsive, part-whole processing and analytic-intuitive style, it loaded highly on its own in factor two. When the 15-minute methodology was employed, convergent-divergent style did correlate with wholist-analytic style but correlational data and principle component analyses are not available to compare it to reflective-impulsive style, analytic-intuitive style or part-whole processing style.

#### **13.5.4 Implications for unidimensional view**

These results offer partial support for the unidimensional view of style demonstrating a consistent relationship between the habitual tendency towards part or whole processing and a tendency to take a reflective or impulsive approach to tasks; these findings were replicated and emerged repeatedly in a number of experimental situations. Those individuals who took longer than average and were more accurate when completing the WAS analysis, which is characteristic of a reflective style, achieved higher ratios, indicating a more analytic style, and were slowed down most by the increase in the number of simple shapes which made up the complex geometric figures in the matching figure trials, indicating that they adopted a part processing approach to complete both the matching figure and the embedded figures tasks.

Similarly those who were slowest and most accurate when completing the matching familiar figures test (MFFT), which is characteristic of a reflective style, produced higher ratios on the wholist-analytic dimension of the CSA, indicating that they were more analytic. Most convincingly, a complimentary effect of reflective and part processing style was evident which inflated analytic ratios when the matching figure subtest was presented first and this was contrasted with the presence of a conflicting effect when the subtest order was reversed which led to the habitual reflective approach cancelling out the effect of the preference for part processing.

The conflict between reflective and part processing approach when then the subtests are reversed also led to a dramatic shift in the ratios achieved across test sessions. At the second test session the reflection style diminished and the styles were no longer in conflict, leading to the WAS-AW producing unstable negative correlations in comparison to the moderately stable WAS-WA.

In summary, reflective-impulsive style had the most consistent links with the other global-analytic style constructs; reflective individuals were more analytic, as measured by the CSA, the WAS analysis and the CSI, and they demonstrated a preference for part processing. The links with the CSA, the WAS analysis and the CSI may have been mediated by the sensitivity of the measures to reflective-impulsive style rather than demonstrating a genuine relationship between reflective-impulsive style and global-analytic constructs, however the tendency for reflective individuals to approach the matching figures task with a part processing approach, as measured by the part-whole ratio, demonstrates an association which is not confounded by other styles. The complimentary nature of reflective-impulsive style and part-whole processing was also demonstrated by the WAS analysis; ratios were more stable when the styles worked in harmony but were less stable when the style were in conflict. Therefore there does appear to be a robust and consistent relationship between the habitual tendency to reflect on response alternatives in situations where accuracy is uncertain and the tendency to choose a part processing approach.

The relationship between the two super-ordinate measures of style was not supported; The CSI did not correlate with the CSA, the WAS analysis or the MFFT, which are all sensitive to both reflective-impulsive style and local-global or part-whole style differences. Further, the CSI did not correlate with the part-whole ratio or convergent-divergent style, but did correlate with reflective-impulsive style when a measure was used that was not sensitive to differences in local-global processing differences. This suggests that the CSI self-report items appear to be measuring control and tempo variables associated with reflective style rather than analytic-global processing differences.

The relationship between convergent-divergent style and wholist-analytic style was equivocal, perhaps owing to the slight difference in the timing used for the divergent test between studies. Convergent-divergent style did not correlate with reflective-

316

impulsive style which may explain its lack of correlation with the CSI and the WAS analysis; it did correlate with wholist-analytic style when the CSA was used but this data has not been replicated. The principle component analysis loaded convergent - divergent style highly on its own factor.

The findings partially support the unidimensional perspective, demonstrating that people with a reflective style are more likely to also have a part processing preference, which is characteristic of an analytic style. Beyond that, the conclusions should be treated with a degree of caution and need further replication, however, two further conclusions can be tentatively drawn; firstly, the CSI is not a similar style construct to the wholist-analytic dimension, and that whilst they are both super-ordinate styles, the CSI appears to be more related to differences in reflection rather than differences in part and whole processing. Secondly, convergent-divergent style is not related to differences in reflective-impulsive style but there is equivocal support for a link between convergent-divergent thinking and individual differences part-whole processing which characterise the wholist-analytic dimension.

Alternately the consistent link found between reflective-impulsive style and global-analytic constructs offers support for Kagan's original conception of reflective style as a determinant of analytic processing (Kagan, et al. 1964) and is consistent with the wider findings in the styles literature. Factor analytic evidence of the link between reflective style and analytic style has been provided by Riding and Dyer, (1987) and Allinson and Hayes (1996) and almost without exception, where links between the style labels have been demonstrated in the literature, reflective style has invariably been one of the correlation variables.

It is clear from the styles literature and from the current findings that one of the most pervasive and damaging problems in the styles research is the lack of valid measures. In particular, the use of accuracy and latency as the basis for measurements invites confounds with reflective-impulsive style, the use of figural items invites confounds

with local-global processing and the use of closed end items invites confounds with convergent-divergent style. The problems with measurement create background noise, which prevent a clear picture of the style relationships from being established. The measurements employed in the test of this thesis were carefully selected with a view to avoid confounds with ability and related styles but, despite this, there are a number of limitations with the methodologies and measures which have limited the conclusions which may be drawn in relation to the unidimensional debate, this will be discussed in respect to future recommendations in 14.6.

### **13.6 Summary, conclusions and recommendations for future research**

The wholist-analytic dimension (Riding, 1991) is a structural theory of style (Coffield et al. 2004) that implies a relatively fixed tendency towards differentiation or synthesis of information, which is likely to have a biological basis. Ridings (1991) construct and the constructs on which it was based, the leveller-sharpener dimension (Holzman and Klein, 1954) and the field independent-dependent dimension (Witkin, 1950), have an intuitive appeal because they echo the way in which many of the perceptual systems organise and process sensory stimuli. The notion that information processing often involves a trade off between thorough, detailed, analytic, bottom up processing versus a quicker, more cognitively economical, global, top down processing is consistent with the way that many of the systems in the brain have been hypothesised to function (Hill and Frith, 2003).

For example in the visual system there are feed forward mechanisms and feedback mechanisms, which mature at different rates, maturation of the bottom up processes occurs first and then the top down processes mature later; problems during the maturational stage may set up a preference for global or local processing (Burkhalter, 1993).

Frith (2003) suggested that a failure during the maturation of the top down systems can occur several times during development across different functional systems and could account for the incidence of weak central coherence, which presents as a tendency to prefer local processing to global processing. Frith's (2003) suggestion relates to the presence of weak central coherence as a clinical symptom of autism but Happe (1999) argued that the autistic phenotype with its link between an impersonal approach and a tendency towards local processing may represent the clinically extreme end of a normal cognitive style continuum along which the whole population is positioned (Frith, 1989; Happe, 1999). Evidence in support of such theorizing is presented in Appendix 1.

The parallels between the notion of strong and weak central coherence (Happe, 1999) drawn from the research on autism and the concept of the wholist-analytic style dimension have not been made in the cognitive styles literature before, but the parallel lends credence to the notion that the population is characterized by a tendency towards a differentiation or synthesis approach to information processing.

The concept of wholist-analytic style therefore makes intuitive sense in a way that many of the multidimensional style theories do not because it proposes individual differences along a continuum based on differentiation and synthesis, which makes good evolutionary sense and has a viable biological basis.

The wholist-analytic dimensions, reflects a unitary perspective of style, which predicts that many of the style constructs are merely measuring different aspects of one super-ordinate dimension. This perspective has been criticised as an oversimplification and the lack of inter-correlations between the style constructs has done little to dispel such criticism (Sadler-Smith and Hodgkinson, 2003).

Since Riding's (1991) initial conception of the wholist-analytic dimension, very little has been done to explore the relationships between subordinate style constructs.

Riding (2005) and Hodgkinson and Sadler-Smith (2003) recommended the administration of a number of cognitive style measures to establish whether they inter-correlate. The current thesis has taken this approach to explore the unitary assumptions of the wholist-analytic dimension by comparing wholist-analytic style with reflective-impulsive style, convergent-divergent style and analytic-intuitive style. Consistent support was found for a relationship between reflective-impulsive style and wholist-analytic style and partial support was found for the relationship between convergent-divergent style and wholist-analytic style. The direction of the relationship was as predicted, wholist individuals were more divergent and impulsive and analytic individuals were more convergent and reflective. There was no relationship between reflective style and convergent style, suggesting that perhaps subordinate style constructs should be considered as uncorrelated predictors of wholist-analytic style.

In this sense correlations between the style measurements may not be strictly necessary to support the unitary dimension of style. If an individual's position on the sub-ordinate style constructs could be considered as predictive of their super-ordinate style then regression models dictate that predictor variables should not correlate with each other. Style could be viewed as a function of the degree to which an individual possesses each aspect of global-analytic style as measured by the principle style dimensions, which form the super-ordinate dimension. Perhaps a useful analogy can be made with left and right sidedness which is a function of preferences for left or right foot, hand, ear, and so on.

Support the unitary perspective is also apparent in the common and repeated distinctions that have been made between social and interpersonal differences in functioning and preferences. It is argued in appendix 1 that convergent-divergent style (Hudson, 1967), field independent-independent style (Witkin, 1950) and wholist-analytic style (Riding, 1991) each discriminate between the same impersonal-interpersonal style differences and therefore have the power to

discriminate among the same social and personal characteristics. The importance of this common discriminatory power has not been given its due; first, it suggests that the styles, which are measuring different aspects of a tendency towards differentiation and synthesis, are also describing similar groups of people and is therefore strong support for the unitary perspective. Secondly, and perhaps more importantly, it brings into focus the pervasive link between differences in social functioning and a tendency to use local or global processing.

This link between impersonal-interpersonal style and local versus global processing leads back to the literature on autism and suggests the existence of a cognitive style phenotype (Happé, 1999), in which local processing is associated with an impersonal style and global processing is associated with an inter-personal style. There are many parallels to be drawn with the research into social functioning and central coherence in autistic individuals, and research has already suggested a genetic basis for the style differences, providing evidence that the fathers of autistic offspring have a non-clinical tendency towards local processing and an impersonal style which reinforce the possibility that some of the clinical symptoms of autism are merely the clinically extreme analytic pole of a normal individual difference continuum (Happé, 1999).

In conclusion the construct of wholist-analytic style has a strong theoretical basis; it remains a promising means of conceptualising individual style differences and of consolidating similar constructs in the literature. The new parallels which have been drawn here with the literature of autism opens the door to a wealth of research which is tackling very similar questions to those being posed in the styles research and could aid the progress of style researchers in establishing a genetic and biological basis for wholist-analytic style.

However, whilst the wholist-analytic construct is judged to have strong theoretical foundations, the method by which it is measured lacks validity and reliability and progress can only be made once these have been addressed.

### **13.6.1 Recommendations to improve the validity and reliability of the wholist-analytic ratio method**

The current research supports the validity of the wholist-analytic dimension but not the method that has been used to measure it. The theory of diminished reflection proposed in this thesis has demonstrated that the confounding influence of reflective style reduces the validity of the wholist-analytic ratio but in doing so the theory also explains the low temporal reliability of the measure and demonstrates a link between reflective-impulsive style and part-whole processing. Additionally, an asymmetry that has been demonstrated in the nature of the processing which underlies the ratio; this too reduces the validity of the measure but simultaneously demonstrates the tendency for analytics to choose part processing approach and for wholists to chose a whole processing approach in a way which to-date had not been satisfactorily evidenced in the styles literature. A number of recommendations can be made to improve the validity and consequently the reliability of the wholist-analytic ratio.

#### ***Controlling for the effect of diminished reflection***

The effect of diminished reflection on the wholist-analytic ratio can be removed very simply by counterbalancing the presentation of the matching figure and embedded figure tasks. It is important that this is not achieved by merely alternating the presentation of the subtests because this would still retain the influence of diminished reflection and would not improve the validity of the measure. Ideally the matching figure tasks and the embedded figure tasks should be combined in the same subtest and presented randomly within that subtest. This approach is the same as that used

for the verbal and imager items in Riding's CSA (1991). In this way, any tendency to begin more slowly during the early test items would equally affect matching figure items and embedded figure items and would therefore have no effect on the wholist-analytic ratio. This would eradicate the influence of reflective style, which will lead to improved validity and consequently improved temporal reliability. The presence or absence of practice items and the issue of biased instruction, which can mediate the effects of reflection and were discussed in Chapter four and five, will become irrelevant if adequate counterbalancing methods are employed.

### ***Rectifying an asymmetry***

The asymmetry in the nature of processing, which forms the basis of the ratio, is potentially more difficult to rectify than the effect of diminished reflection. The wholist-analytic ratio purports to measure an ability difference, which is apparent when individuals use their preferred and non-preferred methods of processing. However, whilst wholists are being measured on their relative ability to employ part and whole processing strategies, to complete tasks which favour part and whole processing; , respectively; analytics are being compared on the efficacy of a part processing strategy to complete tasks which favour or disadvantage a part processing approach. There are two ways to eradicate the asymmetry; either, the matching figures task should be replaced with a task, which can only be completed by using a whole processing approach; or, the embedded figures task should be replaced with a task, which can be completed using either a part processing or whole processing approach but that favour a part processing strategy.

The first option is favourable, since it would ensure that the analytics and the wholists were being assessed based on their relative ability to employ their preferred and non-preferred processing strategy in task appropriate situations. The second option would demonstrate that whole processors habitually choose whole processing strategies and that part processors habitually choose a part processing strategy but the

323

performance differences would stem from the efficacy of part and whole strategies when applied to tasks with congruent and incongruent task demands. In either situation higher ratios would indicate analytic style and lower ratios would indicate wholist style.

The revisions to the CSA outlined above should be applied in stages; the counterbalancing should be employed first since it will improve the validity and reliability without introducing new confounds to the measure. The effect of the counterbalancing, on reliability and validity, should be established before the issue of the asymmetry is addressed, since any change to the tasks in the wholist-analytic measure will potentially introduce new confounds.

### ***Improving the discriminatory power of wholist-analytic subtests***

There is a need for a version of the CSA, which is open to individual item inspection. This will eliminate the trend for new measures to be devised in order to examine the psychometric properties of the wholist-analytic ratio (e.g. Peterson, et al., 2003 and Davies and Graff, 2006). The style measures are very sensitive to small changes in methodology and therefore, use of the same measure of wholist-analytic style is strongly recommended to avoid further confounds. It is recommended that the measure used should be the CSA since it has already amassed a substantial body of literature, but the CSA will be of limited use whilst its output is restricted to summary speed, accuracy and ratio data.

Access to individual item data would allow the discriminative power of the wholist-analytic ratio to be assessed; the current research suggested that only one subtest was discriminating between wholists and analytics, this appeared to be a result of the influence of reflective style and should be eradicated with adequate counterbalancing measures but this merely reinforces the need for analysis at the individual item level if progress is to be made with the validity of the wholist-analytic ratio. Similarly, the

exposure of the systematic effects of diminished reflection on the validity and reliability of the wholist-analytic ratio were only possible using the individual item data provided by the WAS analysis but the effects need to be replicated using the CSA itself.

### **13.6.2 Recommendations for future research**

#### *Effects of counterbalancing on reliability*

Temporal reliability and internal consistency tests should be repeated using a counterbalanced version of the wholist-analytic dimension of the CSA. Matching figure and embedded figure items should be randomised and presented within the same subtest to ensure that any influence of reflective style will equally affect both types of task and therefore have no impact on the ratio calculation. The stimuli used in the trials, the instructions and the test length should remain true to the original CSA. A test-retest reliability study should be undertaken using an interval of approximately twelve months and should aim employ a minimum of one hundred people.

Generally, the sample sizes used in the literature to assess temporal reliability have ranged from twenty-seven to eighty-nine participants (Peterson et al., 2003; Parkinson et al., 2004; Rezai and Katz, 2004; Cook, 2008) with power estimates suggesting fifty people is sufficient to ensure adequate statistical power. The sample size recommended here is higher because with the absence of the influence of reflective style, effect size is anticipated to be lower. Using the effect size of the part-whole ratio as a guide (see Chapter six), a low to moderate effect size is anticipated which will require one hundred participants to ensure adequate test power. The counterbalanced version of the test should allow item level analysis to examine the progress of analytics, intermediates and wholists through the test and

compare this from test to re-test. In addition to the overall test-retest reliability, the test-retest correlations of each style group should be investigated to identify the source of any instability.

### ***Relationship between the styles constructs***

More needs to be done to establish the relationship between styles in the wholist-analytic family and between the subordinate styles and super-ordinate styles; a number of recommendations can be made for testing of the unidimensional perspective. It is recommended that a sample of one hundred people be assessed on their wholist-analytic style, reflective-impulsive style, leveller-sharpener style and convergent-divergent style.

Wholist-analytic style should be assessed by using a revised version of the wholist-analytic dimension of the CSA, as described above, which employs adequate counterbalancing should be employed to measure wholist-analytic style to provide a valid measure of part-whole processing without the confounds of reflective-impulsive style. Leveller-sharpener style should be measured by the traditional schematising test.

The test of convergent-divergent style using the methodology employed in Chapter twelve has proved to be a reliable measure of style with very good discriminant validity and standardisation of performance allows a relative convergent-divergent score to be calculated. When choosing convergent items it is important to include an equal number of verbal and non-verbal items and when using the object uses test as the divergent measure, participants should be allowed fifteen minutes to complete it.

Reflective-impulsive style should be calculated in one of two ways, either the median speed of processing the forty items on the wholist-analytic measure and the number of errors made during completion should be used as an indicator of reflective-impulsive style; or the MFFT-20 should be employed. Unlike the traditional matching familiar figures test, both these measurements will control for the influence of local-global preferences, however, care should be taken to assess the presence of ceiling effects in the accuracy variable. In either case, the median split method should be used to create style groups rather than using a continuous style variable. This is because the slow-inaccurate and fast-accurate individuals cannot be treated as intermediate between the reflective and impulsive style groups; their reflective or impulsive behaviour is mediated by efficiency, which masks their style.

If the subordinate variables demonstrate a relationship lower than  $r = .3$  or  $.4$  then multiple regression techniques should be employed with wholist-analytic style as the criterion variable to assess their role as predictor variables. A sample of 100 people would be sufficient for a multiple regression using four variables and would also be a minimum requirement for a principle component analysis.

### ***Unipolar or bipolar effects: the source of the ratio difference***

Using a revised measure of wholist-analytic style, which employs adequate counterbalancing and allows an item level analysis the power of each group of tasks to discriminate between wholists and analytics should be determined. This is particularly important in light of the asymmetry which has been exposed in this thesis.

If the discriminate power of the wholist-analytic ratio is derived predominantly from the matching figures tasks then the ratio reflects a tendency to choose a part or whole processing style but does not provide any evidence relating to relative abilities to use either strategy. In this case wholists and analytics may be equally efficient using part

or whole strategies but just have a tendency to employ one or the other when a choice is possible.

If on the other hand the power of the ratio is predominantly derived from the embedded figure tasks then this suggests a unipolar difference in disembedding ability which is akin to measures of field independence-independence and is therefore subject to the same criticisms relating to issues of intelligence and efficiency.

The third outcome is that the ratio as derived from differences in performance in both types of tasks. This would demonstrate a difference in disembedding ability and a preference for part or whole processing but further tests would be needed to assess any difference in ability to whole process, since it has been shown in Chapter nine that this is not measured by the wholist-analytic dimension, because analytics use part processing for all tasks.

#### ***Increasing the complexity of the wholist-analytic style measure***

Riding recently recommended the development of a more difficult test of wholist-analytic style, stating that “a problem with the existing WA test is that the items are very easy and it depends on rather fragile response times, there could be a test of relative performance on harder items.” (Riding, 2005, p.13). The present findings urge caution with taking this approach unless the matching figure and embedded figure items are first counterbalanced. In its present form, any increases in complexity may well exacerbate the confounding influence of reflective style. However, in conjunction with adequate counterbalancing the increase in complexity should amplify the size of the effect between style groups and would also offer a better indicator of reflective-impulsive style, as described in 14.8.2 which would be less susceptible to ceiling effects.

### ***Exploring the cognitive style phenotype***

The theory that the clinical symptoms of weak central coherence and problems with interpersonal functioning, which characterise individuals with autistic spectrum disorder, is merely a clinically extreme end of a cognitive style continuum (Happe, 1999; 2006) opens an interesting avenue of research which could explain the pervasive link between global-analytic styles and interpersonal-impersonal styles of social functioning. The methodology outlined in 13.8.1 could be extended to include a measure of social functioning and could inform the unidimensional versus multi dimensional debate.

The notion of a phenotype implies a genetic component to cognitive style and studies have shown evidence of an increased incidence of impersonal styles and bias' for local processing in the close relatives of autistic individuals (Baron-Cohen and Hammer, 1997; Happe et al., 2001; Hill and Frith, 2003). These findings need to be replicated in non clinical samples to support a genetic basis of style; in particular the fathers of analytic individuals should be assessed to establish any relationship between styles.

### ***Biological basis of style***

Another new direction, inspired by the literature on autism, is the link between brain maturation and cognitive style. If a lack of synaptic pruning during the maturation of systems relating to global processing (Burkhalter, 1993) is the source of local processing preferences then drawing on Geschwinds maturational hypothesis (Geschwind and Galaburda, 1987), there may be a link between individual differences in maturation rate and preferences in global-local cognitive styles.

Early maturers may spend proportionately longer in the local processing maturational phase and late maturers may spend proportionately more time in the global processing maturational phase. It would be interesting to explore a possible link between brain maturation and wholist-analytic cognitive style.

Onset of puberty is an indirect but practical and robust correlate of brain maturation. Individual differences in maturation rates can be attributed to a genetic cause or an environmental cause such as children being born to older mothers; sex differences may also be a factor in maturation rates. These variables should be considered in any investigation relating to maturational rates and cognitive style.

The key to successfully addressing the research questions outlined above is the availability of a reliable and valid measure of style. The wholist-analytic dimension of style has a large research base and strong theoretical foundation and the recommendations made in this thesis should lead to the improved validity and reliability of the wholist-analytic ratio.

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## **List of Appendices**

Appendix 1: Impersonal, Analytic Style versus Interpersonal, Global Style

## **Appendix 1: Impersonal, Analytic Style versus Interpersonal, Global Style**

### **1.1: Introduction**

Chapter three demonstrated the lack of satisfactory correlational evidence to support the unitary perspective of style; however, there are robust individual differences in social and interpersonal functioning and preferences, which provide a common thread linking the global-analytic constructs together. Impersonal-interpersonal style was reported independently in the early convergent-divergent style (Hudson, 1967) and field independent-dependent style (Witkin, 1950) research. The differences continue to be reported in relation to the more recent super-ordinate conception of wholist-analytic style (Riding, 1991; 1998; 2005).

The implications of the association between global-analytic style and interpersonal-impersonal style seem to have been largely missed; the robust link demonstrates striking parallels with current autism research, which may be the key to establishing the genetic and biological basis of style.

Autistic individuals are characterised by impaired social functioning (A.P.A. 1995; Hill and Frith, 2003; Begeer, Koot, Rieffe, Terwogt and Stegge, 2008) and they also demonstrate ‘weak central coherence’ which is a term used in the autism literature to refer to a local processing style (Happe, 1999; Hill and Frith, 2003). Autistics have superior function on the EFT (Shah and Frith, 1983; Jolliffe and Baron-Cohen, 1997); and demonstrate a tendency for local processing over global processing across a number of tasks and modalities (Hermelin and O’Connor, 1967; Shah and Frith, 1983; Frith and Snowling, 1983; Snowling and Frith, 1986; Tager-Flusberg, 1991; Happe, 1997; Happe, 1999).

The autism literature has suggested that the autistic phenotype may represent the extreme end of a cognitive style dimension, which is characterised by differences in social functioning and global versus local processing (Happé, 1999; Hill and Frith, 2003).

Autism research and the notion of an autistic phenotype as an extreme at the analytic pole of a global-analytic dimension may offer the coherence and credibility, which the cognitive styles literature currently needs. At the very least, it should inform the ongoing unidimensional versus multidimensional style debate.

### **1.2: Social and interpersonal functioning in cognitive style**

Consistent differences in the social and interpersonal preferences of those with global or analytic styles have been noted throughout the literature. The distinctions drawn from the early literature relating to field independent-dependent style and convergent-divergent style are particularly convincing because they were reported independently of each other.

Field dependent individuals have been characterised as having an interpersonal orientation and field independent people as having an impersonal orientation (Witkin and Goodenough, 1981). A similar distinction has been drawn between convergers and divergers, Hudson writes “the converger takes refuge from people in things – the diverger takes refuge from things in people” (Hudson, 1967, p.109).

Field dependents are more attentive to social information; they spend more time looking at faces (Konstadt and Forman, 1965; Ruble and Nakaura, 1972) and consequently are better at recall of faces (Crutchfield, Woodworth and Albrecht 1958; Messick and Darmarin, 1964). This also extends to verbal social information (e.g. Fitzgibbons and Goldberger, 1971; Goldberger and Bendich, 1972). Field dependents prefer situations that bring them into contact with others whilst field

independents are more solitary (Witkin and Goodenough, 1981), these preferences impact on career and educational choices (Witkin, 1976; Witkin et al. 1977). Field dependents are described as being “more open with their feelings” (Witkin and Goodenough, 1981, p.44).

Donoghue, McCarrey and Clement, (1983) found that field dependents were more affected by social facilitation than field independents. Their laughter was enhanced to a significantly greater extent by the presence of a confederate. Saracho and Spodek, (1981; 1986) also found field dependent individuals to be more social and interested in others.

Social differences have also been identified in childrens’ play behaviour; field dependent children have been found to engage in a greater variety of play behaviours, select more social play areas and engage in more associative play, which involves interaction whereas field independent children engage more in parallel play where children play next to each other without interacting (Saracho, 1998).

Hudson (1967) makes a number of comparable distinctions between convergers and divergers. Divergers’ drawings more often featured people than convergers’ drawings; the converger avoids discussion of a personal nature whilst the diverger “positively seeks it out” (Hudson, 1967, p.109). The diverger prefers the human aspects of culture, literature and politics whereas the converger prefers the technical and the practical. In describing the converger, Hudson notes “his concentration upon the impersonal aspects of his culture, both in school and out.” and “the caution with which he expresses his feelings. At some stage in his life he seems to have turned his back on the sphere of personal relations, and focussed all his attention on areas where people and personal emotions are least likely to obtrude” (Hudson, 1967, p.102-103)

More recently, similar interpersonal distinctions have been reported in the CSA literature thereby providing a strong link between the subordinate and super-ordinate styles.

Riding and Craig (1998) found that wholists were considered more sociable, and more pleasant and likeable. Analytics were considered more solitary, more unsociable, had a tendency to blame others and lacked empathy. Riding and Craig (1999) found that within a sample of boys exhibiting problem behaviour in special schools, analytics were more often reported for incidences of solitary behaviour. Similarly, Riding (1991) stated that wholists are more dependent and gregarious whilst analytics are more isolated and self-reliant.

Interestingly, there also appears to be interpersonal differences between verbal and imager styles. Riding (1994) stated that verbal individuals focus outward toward others, preferring a stimulating environment. Their social group will be an extension of themselves. Imagers, on the other hand, focus inward, are more passive and content with a static environment. Their social group are distant from themselves and they are less socially aware. Following the notion of unitary and complimentary styles proposed by Riding and Sadler-Smith (1992), this suggests that wholist-verbalisers and analytic-imagers have unitary interpersonal styles and wholist-imagers and analytic-verbalisers have complimentary interpersonal styles. This is contrary to the complimentary and unitary pairings, which are based on wholist and analytic processing.

The link between global-analytic processing and interpersonal-impersonal style parallels the characteristic differences seen in autistic individuals and autism researchers have themselves drawn parallels with the notion of autism as a clinically extreme end of a normal cognitive style dimension.

### **1.3: Cognitive style and the autistic phenotype**

In a 2003 review of the autism literature, Hill and Frith identified two current theories, which universally characterise autistic individuals; these are social impairments and a bias towards local processing. Naturally, these characteristics are clinically extreme but they each have parallels in the cognitive styles literature.

#### **1.3.1: Social impairments**

Autistic individuals have social impairments, which can make them appear aloof and withdrawn from other people (Hill and Frith, 2003). The diagnostic statistical manual of mental disorders characterises the social impairments of autistic disorders as “marked impairments in the use of multiple nonverbal behaviours such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction”, “a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people” and “a lack of social or emotional reciprocity” (A.P.A. 1995, p. 72)

Begeer et al. (2008) reviewed empirical studies that considered emotional competence in autism; they reported that, at one year old, children with autistic spectrum disorders (ASD) looked less at faces and people (Osterling, Dawson and Munson, 2002; Palomo, Belinchon and Ozonoff, 2006); at three to four years old they were less attracted to human faces (Dawson, Carver, Meltzoff, Panagiotides, Partland and Webb, 2002). ASD individuals also showed impaired identification and memory for faces but not for objects (Davies, Bishop, Manstead and Tantam, 1994; Boucher, Lewis and Collis, 1998; Blair, Frith, Smith, Abell and Cipolotti, 2002)

The impaired memory and identification of facial stimuli has been attributed to ASD individuals focussing on discrete elements rather than integrating the facial stimuli into a coherent whole. Evidence for this comes from the finding that when face

stimuli is inverted ASD individuals demonstrated no impairment and sometimes show superior performance in identification of facial stimuli (Tantam, Monaghan, Nicholson and Stirling, 1989; Teunisse and de Gelder, 2003).

ASD individuals also appear to focus on different facial details than control subjects; individuals without ASD tend to focus relatively more on the eye region than the mouth, whereas ASD individuals focus on the mouth area relative to the eyes (Joseph and Tanaka, 2003; Klin, Jones, Shultz, Volkmar and Cohen, 2002).

Autistics show impairments in face recognition and the reading of emotion from the eyes, which have been demonstrated at a physiological level (Critchley, Daly, Bullmore, Williams, Van Amelsvoort, Robertson, Rowe, Phillips, McAlonan, Howlin and Murphy, 2000; Shultz, Gauthier, Klin, Fulbright, Anderson, Volkmar, Skudlarski, Lacadie, Cohen and Gore, 2000; Pierce, Muller, Ambrose, Allen and Courchesne, 2001).

School aged children and adults are also generally less emotionally expressive during social interaction; they demonstrate more neutral, flat or idiosyncratic expressions (Czapinski and Bryson, 2003). They also laugh less with others during social interactions (Reddy, Williams and Vaughan, 2002).

### **1.3.2: Local processing bias**

Autistic individuals are characterised by having ‘weak central coherence’. This describes ‘a tendency to focus on local, rather than global aspects of an object’ (Hill and Frith, 2003, p. 283). They display this tendency in verbal and non-verbal tasks.

### *Non-verbal processing tasks*

Autistics demonstrate superior performance on Witkin's embedded figures test (Shah and Frith, 1983; Jolliffe and Baron-Cohen, 1997) and on the block design test from the Wechsler Intelligence test (Shah and Frith, 1983).

This finding should be particularly interesting to cognitive style researchers because the same connection between performance on the EFT and the block design tasks have been documented in the styles literature; in fact it is one of the reasons why the EFT has been accused of measuring ability rather than style because it correlates with some intelligence test items. However the correlation between superior performance on the EFT and superior performance on the block design task, amongst autistics, remains even with low functioning autistics that are characterised by very low IQs around seventy (Happe, 1999).

Shah and Frith (1983) have also demonstrated that the superior functioning of autistics in comparison to controls on the Wechsler block design test is a result of their tendency to part process objects rather than be distracted by the gestalt view of the block designs. When the blocks were artificially segmented, control subjects improved to the level of autistics but there was no improvement for autistics.

Autistics are also less susceptible to visual illusions that rely on interference from context. The Titchener circles illusion presents two small circles embedded within two larger circles. The task requires respondents to judge whether the two inner circles are the same size and this task is made more difficult in the context of the larger circles. Autistic individuals gave more accurate judgements than normal controls or controls with mild learning disorders (Happe, 1996).

Further, when the illusion was presented in three-dimensional form, which helped to artificially disembed the inner circles from the outer circles, the control groups

improved to the level of the autistics but the autistics showed no improvement. This suggests that the superior performance of the autistics in the two-dimensional version of the illusion can be attributed to them being less affected by the interference of context (Happe, 1996).

### ***Verbal processing tasks***

The tendency towards local processing in preference to global processing in autistics is also apparent in verbal-semantic tasks. The usual tendency for individuals to recall more information if it is linked semantically rather than unrelated strings of words is diminished in autistic individuals (Hermelin and O'Connor, 1967; Tager-Flusberg, 1991), they also perform similarly on Bartlett's (1932) story recall task whether they are given a cue to the context or not, whereas, normal controls recall more information when cues to context are provided.

The effect is not just limited to verbal memory tasks; autistics also fail to process global semantic context when reading homographs (Frith and Snowling, 1983; Snowling and Frith, 1986; Happe, 1997). For example, when reading the following sentences "In her eye there was a big tear" and "In her dress there was a big tear" (examples taken from Happe, 1999), autistic individuals failed to use the sentence context to inform the pronunciation of the homograph "tear".

Even more interestingly, when the autistics were prompted to use the sentence context to assist their pronunciation of the homographs, they successfully did so, suggesting that the tendency to locally process the words, at the expense of globally processing the sentence context, is a cognitive style not a lack of ability (Snowling and Frith, 1986).

#### **1.4: Increased incidence of social impairments and processing bias in family members**

The social impairments and local processing biases which are characteristic of the autistic individual are also found more frequently in the close relatives of those diagnosed with autistic spectrum disorders.

Baron-Cohen and Hammer (1997) found that the parents of ASD individuals were less able than controls to identify emotion from eyes and were more field independent than controls on the embedded figures test.

Happe, Briskman and Frith, (2001) found that the fathers and brothers of autistic individuals performed better on the Wechsler Block design test, were more field independent on the EFT and were less susceptible to visual illusions that relied on context interference.

In non-autistic family members, the detail focussed style is not considered an impairment and in many ways is viewed as an asset, particularly to their chosen careers; higher numbers of fathers with autistic children are found in engineering careers than would be expected by chance (Hill and Frith, 2003)

The incidence of social impairments and local processing style in the families of individuals with ASD is important in three ways; it provides further evidence that an interpersonal style tends to occur in those with local processing biases, or vice versa; it supports the notion that the clinical signs of ASD represent an extreme end of a style continuum, since the family members have similar characteristics but to a lesser, non-clinical, degree; and, it suggests a genetic basis to these differences which imply a neurobiological substrate.

## **1.5: Neurobiological basis of social impairments and local processing**

The focus of autism researchers is on identifying the neurobiological substrates of social impairments and local processing differences and gaining insight into the behavioural aspects of ASD to inform assessment and intervention (Noens and van Berckelaer-Onnes, 2008). To this end they face the same research challenges as cognitive style researchers and they have a number of theories relating to the biological bases of impersonal style and local processing biases, which could inform the cognitive style literature.

Baron-Cohen, Ring, Williams, Wheelwright, Bullmore, Brammer and Andrew (1999) found that during a task, which involved judging emotion from a photograph of peoples' eyes, fMRI data revealed that ASD individuals showed less activation of the frontal lobes and no activation in the amygdala.

ASD individuals are characterised by a lack of understanding or attribution of mental states to others, termed mentalisation, which leads to their impersonal style (Hill and Frith, 2003). These impairments are demonstrated by less activation of the medial prefrontal region (Happe, Ehlers, Fletcher, Frith, Johansson, Gillberg, Dolan, Frackowiak and Frith, 1996; Castelli, Frith, Happe and Frith, 2002) and temporal regions (Castelli et al., 2002) during tasks that involve mentalisation.

Neurobiological explanations for local processing bias focus on a lack of neuronal pruning during development and are expected to have a genetic basis. The theory suggests that bottom up, local processing occurs at an earlier stage in the maturation of the brain than top down, global processing.

In ASD individuals, the bottom up maturation proceeds normally but the top down maturation stage does not proceed through the normal process of neuronal pruning,

which either has a detrimental effect on the efficiency of global processing (Burkhalter, 1993) or an enhancing effect on the ability to discriminate or in extreme cases could lead to perceptual overload (Gerland, 1997). This abnormality in development can occur in any system of the brain and could therefore account for an array of cognitive differences, which have a local-global basis (Hill and Frith, 2003).

## **1.6: Summary and conclusions**

The most robust link between the constructs in the style literature is their tendency to discriminate between individuals with interpersonal styles and those with impersonal styles. The social differences which have repeatedly been reported in relation to cognitive style constructs provides a common thread which binds the styles together, demonstrating a relationship which correlation studies, based on style performance measures, have failed to do.

The link between global-analytic styles and interpersonal style is further strengthened by their occurrence in individuals with autism. The brief insight into the autism literature presented here is not intended as an exhaustive review and is necessarily an oversimplification of the bases and definitions of autism; its inclusion here is intended to highlight the similarities between the styles and the autism literature and to suggest new and potentially fruitful avenues of research.

The impersonal characteristics and local processing tendencies of autistic individuals provide a clue to a phenotype of cognitive style, which could inform current research and suggest future directions. It may be that autism represents the clinical pole of global-analytic style, if this were the case; the more exaggerated deficits and enhancements which are present in clinical samples are likely to give a clearer picture of the behavioural aspects and the neurobiological substrates of style. Comparisons between clinical samples and normal controls are likely to yield larger effects than comparisons between global and analytic individuals in non-clinical

populations. The clinical data could be used to shape hypotheses that could be applied to non-clinical populations.

The increased frequency of field independent style and impersonal style in the family of individuals diagnosed with autism supports the notion that style has a genetic basis and demonstrates how a genetic basis can lead to degrees of severity from normal individual differences in some family members to clinically significant symptoms in others.

In the context of the discussion of validity of the wholist-analytic dimension; recurring interpersonal-impersonal style differences have been demonstrated in at least two of the principal subordinate styles; field independent-dependent style and convergent-divergent style. The same individual differences have been discriminated by the wholist-analytic dimension and have been echoed in clinical populations characterised by local processing biases. This supports the notion that the style constructs are related, to the extent that they discriminate between the same category of differences in social functioning and preferences. From this perspective, each aspect of global-analytic style, as measured by the constructs in the wholist-analytic family should be predicted to discriminate between the same interpersonal-impersonal characteristics.

In conclusion, whilst the predictive validity and construct validity of the wholist-analytic dimension have been questioned in chapter two and three, the recurring links between analytic-impersonal characteristics on the one hand and wholist-interpersonal characteristics on the other, provides support for the notion that the styles in the wholist-analytic family may well be measuring different aspects of a global-analytic style which has been repeatedly linked with an interpersonal-impersonal style.