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Personality and Individual Differences 38 (2005) 1269–1281

PERSONALITY AND INDIVIDUAL DIFFERENCES

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A new measure of Verbal–Imagery Cognitive Style: VICS

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Received 19 December 2003; received in revised form 11 July 2004; accepted 9 August 2004
Available online 2 December 2004

Abstract

Concern has been raised about the reliability of Riding's (1991) verbal–imagery dimension of the popular Cognitive Style Analysis (CSA) test (Peterson, Deary, & Austin, 2003a, 2003b; Rezaei & Katz, 2004). This led Peterson (2003) to develop a new test of Verbal–Imagery Cognitive Style (the VICS test). We report the development of the VICS test and the findings from two studies which compare the reliability of the VICS with the CSA's verbal–imagery dimension. In the first study, 50 participants completed the VICS and the verbal–imagery dimension of the CSA test twice, about a week apart. The verbal–imagery style ratios, which are used in both tests to assess a person's verbal–imagery cognitive style, showed high internal consistency ($r > 0.72$) and acceptable stability at re-test ($r = 0.56$.) on the new VICS test, but there was poor internal consistency ($r < 0.03$) and low test re-test reliability ($r < 0.31$) on the CSA and an extended version of the CSA. The second study confirmed these results in an independent sample of 100 participants. It is concluded that the new VICS test is a reliable measure of verbal–imagery cognitive style.

Keywords: Cognitive style; Verbal; Imagery; Measurement; Reliability

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0191-8869/$ - see front matter
doi:10.1016/j.paid.2004.08.009

1. Introduction

Cognitive styles are an individual's habitual or preferred way of processing information (Allport, 1937) and they are believed to affect the way a person learns, thinks, perceives and behaves (see Riding & Rayner, 1998 for a review). This wide sphere of influence is leading to claims that styles may be unexploited factors in individual differences research. In the past, style measures have frequently been criticised for lacking psychometric rigour and predictive validity (e.g., Furnham, 2001; Teidemann, 1989). Recently, however, a few style measures have begun to emerge with more established psychometric properties and closer links with the psychological literature (Sternberg & Zhang, 2001).

A major turning point for style research in the UK was Riding and Cheema's (1991) paper which surveyed approximately 30 different cognitive styles and concluded that most of them measured two broad style dimensions: a verbal–imagery dimension (which indicates a preference for representing information using pictures or words) and a wholistic–analytic dimension (which indicates a preference for information to be structured to get the big picture or the detail). Riding (1991) subsequently proposed a computerised Cognitive Styles Analysis (CSA) test which measures style on these two broad dimensions. The CSA is currently the most frequently used computerised measure of cognitive style in the UK and it is also popular in European universities and organisations (Rezaei & Katz, 2004).

While no research has been conducted into the specific information processing factors that underlie the CSA's method of measuring cognitive style, Riding and colleagues have published over 30 peer-reviewed papers indicating some validity and practical application (cf. Mayer & Massa, 2003). This has led to claims that the CSA has strong theoretical support and a structure more powerful than that of other style tests (Rezaei & Katz, 2004). However, the CSA test and particularly the CSA's verbal–imagery dimension was recently found to be unreliable (Peterson, Deary, & Austin, 2003a, 2003b; Rezaei & Katz, 2004) and not internally consistent (Peterson et al., 2003a, Peterson, Deary, & Austin, 2003b). Rather than abandoning the test altogether, Peterson (2003) and Peterson et al. (2003a) made several recommendations for improving the test, especially the measurement of the verbal–imagery dimension. This paper briefly outlines the main concerns Peterson (2003) had with the CSA's verbal–imagery dimension (CSA-VI) and how the new VICS test addresses them.

1.1. The CSA's verbal–imagery test

The CSA-VI assesses verbal–imagery cognitive style (VICS) by comparing the time participants take to answer verbal and imagery questions. The verbal questions involve comparing the categories of two objects e.g., ''Are 'Skiing' and 'Cricket' the same type?''. Riding (1997) argues that this is a verbal task because it requires identification of the semantic conceptual category, which is verbally abstract in nature and therefore cannot be represented in the visual form. The imagery question involves comparing the colour of two objects (e.g., ''Are 'Lettuce' and 'Lawn' the same colour?''). Riding argues that this is an imagery task because to compare the colour of two objects requires the generation of a mental picture. The ratio of the participant's average 'verbal' reaction time to their average 'imagery' reaction time is then calculated, and the value of this ratio is compared to a set of style norms associated with particular style types: verbal, bimodal, imagery.

There are three main limitations with this method of assessment. Firstly, few objects in the world are exactly the same type or colour and therefore some of the CSA's verbal-imagery items (CSA-VI) could be construed as ambiguous. For example, the CSA-VI's verbal question "Are 'Chicken' and 'Beans' the same type?" and imagery question "Are 'Cream' and 'Paper' the same colour?" both require a 'Yes' response to be correct, although a 'No' response is also plausible. Secondly, the subjective nature of some of the CSA-VI stimuli might, paradoxically, slow the reactions of extreme verbalisers or extreme imagers, who may be more precise in making judgements within their preferred style mode. This is problematic because the CSA calculates style based on the assumption that people process the stimuli from their preferred dimension faster. Finally, the CSA-VI uses a word based task to assess both verbal and imagery style.

1.2. The verbal–imagery cognitive styles test

While the VICS test makes the same assumptions that individual differences in style can be tapped into using a verbal or imagery question, the VICS test was designed to be an improvement on the CSA-VI by avoiding the limitations outlined above. It is proposed that a more appropriate verbal question is to ask whether two items are 'man-made' or 'natural'. Following Riding's (1991) example, we made the assumption that this new question is verbal because it requires the subject to identify the semantic conceptual category to which the items belong. The advantages of our new question is that it allows the experimenter to use a wide variety of objects and the distinction between what occurs naturally versus what is man-made us easy with an appropriate choice of common objects.

To assess the verbal-imagery dimension, a more suitable task (based on Paivio's (1975) experiment) would be to present participants with two objects and ask them to judge which object is bigger in real life. Again, following Riding's (1991) example, we assumed that this question is an imagery task because it requires the participant to visualise the objects in order to accurately compare their size. Moyer and Bayer's (1976) work on the symbolic distance effect supports the idea that the judgement of size requires the generation of an image. The imagery question we employed has two advantages. Firstly, objects can be chosen which are indubitably of different sizes. Secondly, the same verbal stimuli (i.e., natural and man-made objects) that are used in the verbal task can be employed for the size judgement (imagery) task. This helps to keep the verbal and imagery tasks as similar and possible and in turn makes the relative performance on each task more comparable. Using the same stimuli for both verbal and imagery tasks eliminates differences between the verbal and imagery tasks in word agreement (the degree to which an image provokes a particular word), image agreement (the degree to which a word provokes a specific image), word frequency and word familiarity. Finally, the VICS test presents each stimulus in both pictures and words, enabling experimenters to investigate style preferences across the verbal and imagery tasks and also between the picture-based and the word-based stimuli within these tasks.

Given that Riding's (1997) assumption is correct and individual differences in cognitive style can be identified by comparing the speed of response to verbal and imagery questions, this study hypothesises that the design of the new VICS test will also be able to detect individual differences in verbal and imagery processing. We also hypothesise that these individual differences will be more reliable than those measured by the original verbal–imagery dimension of the CSA.

This study consists of two experiments. The first examines 50 participants on the VICS and CSA-VI and an extended version of the CSA-VI. The second attempts to replicate the results in an independent sample of 100 participants.

2. Experiment 1

2.1. Methods

2.1.1. Participants

Experiment 1 employed 50 participants, the majority of them being students from the University of Edinburgh. The mean age was 27 years (SD = 8.8; range 18–59) and the average number of years of education was 17 (SD = 2.7; range = 10–25). All spoke English as their first language.

2.1.2. Apparatus

Three E-PRIME programs were created. Task 1 was the newly designed VICS test. Task 2 was an exact copy of the original verbal–imagery dimension of Riding's (1991) CSA test (CSA-VI) (see Peterson et al., 2003a, 2003b, for more details). Task 3 was a parallel version of the CSA-VI (see Peterson et al., 2003a, 2003b for more details).

2.1.3. Stimulus materials

The stimulus materials for the original and parallel version of the CSA-VI have been reported elsewhere (Peterson et al., 2003a).

The verbal section of the VICS task required participants to answer the question "Are 'X' and 'Y' natural?" to which the participant could respond "Yes", "No" or "Mixed" (i.e., stimuli in which one object is man-made and the other is natural). Each stimulus was presented in a word form and a picture form (Figs. 1 and 2). In both the VICS and the CSA, feedback on correctness was given after each response.

The imagery section of the VICS test required participants to answer the question "Is 'X' bigger than 'Y'?" (in real life), to which the participants could answer "Yes", "No" or approximately "Equal". Like the verbal section of the VICS, each stimulus was presented in a word form and in a picture form (see Figs. 3 and 4).

The number of stimuli used in the VICS test and the component breakdown is shown in Table 1. Within each task (verbal, imagery), the stimuli presented in the word form (e.g., Figs. 1 and 3) contained the same core items as the stimuli presented in the picture form (e.g., Figs. 2 and 4): the pictures and words within each task differed only in form not in content. This was done to see if individuals responded differently to the picture and word based stimuli. Note, mixed stimuli were

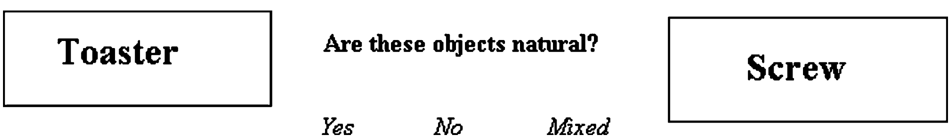

Fig. 1. Example of a verbal item in the word form.

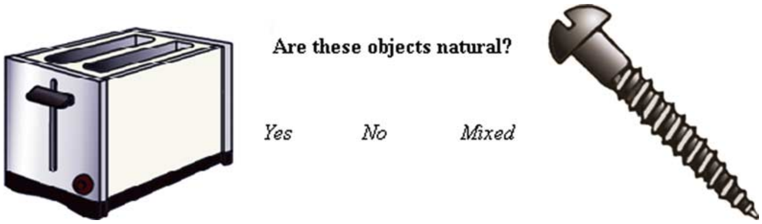

Fig. 2. Example of a verbal item in the picture form.

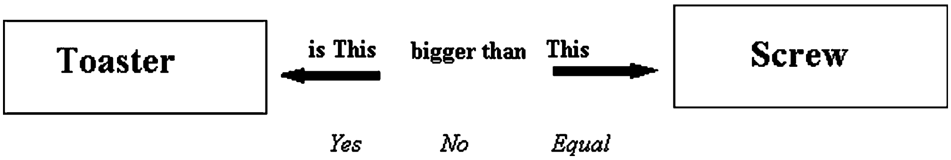

Fig. 3. Example of an imagery item in the word form.

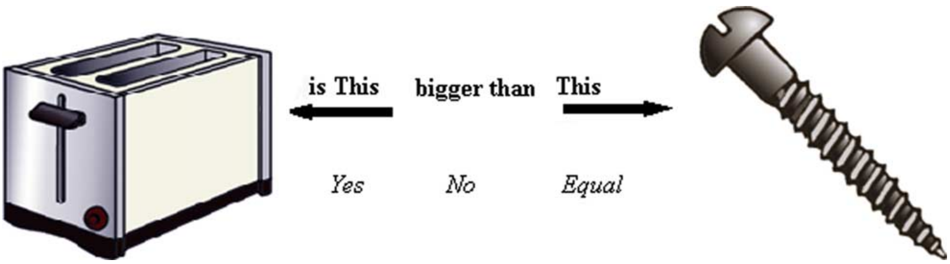

Fig. 4. Example of an imagery item in the picture form.

Table 1
The number of stimuli (in brackets) used in the verbal–imagery cognitive styles test and their component breakdown

Verbal–imagery cognitive style (VICS) test (232 stimuli)											
Verbal task (116)						Imagery task (116)					
Words (58)			Pictures (58)			Words (58)			Pictures (58)		
N (26)	Mn (26)	Mx (6)	N (26)	Mn (26)	Mx (6)	B (26)	S (26)	E (6)	B (26)	S (26)	E (6)

Key: N, natural; Mn, man made; Mx, mixed; B, bigger; S, smaller; E, equal.

used in the verbal task to encourage participants to look at both items in each stimulus. If both items in the verbal task were always natural or always man made, participants could respond correctly by looking only at one item and assume the nature of the other item. Consequently three possible responses for the verbal task were employed (Yes, No, Mixed) and therefore three responses were required for the imagery task (Yes, No, Equal) in order to keep the tasks as similar as possible. However, as approximately equal sized objects are more ambiguous and therefore harder to find, only 12 equal stimuli (six in word form and the same six in picture form) were employed.

The objects used in the verbal and imagery sections of the VICS test were chosen from Rossion and Pourtois' (2001) coloured images, which were based on Snodgrass and Vanderwart's (1980) black and white drawings. The Snodgrass and Vanderwart images are drawn to precise guidelines in terms of style and orientation and have been normed for various attributes. Using these norms, no statistically significant differences were found between the man-made and natural stimuli in terms of name and image agreement, word frequency and age of acquisition and no significant differences were found between the bigger, smaller and equal sized stimuli on these factors. Therefore, any differences in participants' performances on the verbal and imagery tasks (which use the same stimuli) and any differences in responses to particular types of stimuli within each section of the test (man-made, natural, mixed; bigger, smaller or equal) are unlikely to be due to differences in name and image agreement, word frequency or age of acquisition.

2.1.4. Design

In keeping with Riding (1991), the CSA-VI and the parallel version of the CSA-VI presented all verbal and imagery items together in a pseudo random order (see Peterson et al., 2003a). The order of the stimuli in the verbal section of the VICS test was randomised except for the following rule. Half of the verbal stimuli were presented to the participant in the word form first. The remaining verbal stimuli were presented in the picture form first. After all the verbal stimuli had been presented once, the stimuli were presented again (second exposure) in their alternative form. The same procedure was used in the imagery section. This procedure meant that stimuli could be identified as falling into four categories: verbal task first exposure; verbal task second exposure; imagery task first exposure and imagery task second exposure.

2.1.5. Procedure

Participants were tested individually in a quiet room. Each participant completed the VICS test (approximately 15 min) followed by the CSA-VI and the parallel version of the CSA-VI (approximately 10 min) at both session 1 and session 2. Session 2 occurred approximately a week after session 1 (M = 10.5 days, MD = 7.5 days, range = 6–33 days). Participants were told that none of the tests were measuring intelligence or ability. They were also told to work continuously, at their own rate and that they should try to be as accurate as possible.

A set of instructions was presented on the computer screen before each test. The instructions for the CSA-VI and the parallel version were the same as Riding's (1991) test. The instructions for the VICS test were given before both the verbal and the imagery sections. Example items for, and definitions of, man-made, natural, mixed, bigger, smaller and approximately equal were also given. A practice session followed each set of instructions. Reaction times were measured from stimulus onset to stimulus response for each item and the accuracy of each response was recorded.

2.1.6. Power

In studying the reliability of a psychological measure it is appropriate to power the study to detect coefficients in excess of about 0.5. Coefficients below that would indicate poor reliability. With alpha set at 0.05 (two tailed) and with $r = 0.5$, this study ($N = 50$) had a power of 96%. Adequate power is usually considered to be 80% or above. The study had 80% power to detect an effect size of 0.39, which is well below the value that would indicate a satisfactorily reliable test.

2.2. Results

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

2.2.1. Results of the VICS test

Accuracy, mean and median reaction times were recorded for each test section (verbal, imagery), session (1, 2), each stimulus form (pictures, words) and each stimulus exposure (verbal first exposure, verbal second exposure, imagery first exposure, imagery second exposure). Analysis of variance (ANOVA) based on the median and mean reaction times were also conducted. However, as the key variables of interest in this paper are the reliability of the reaction time ratios, not differences in reaction time means, the ANOVA results are not reported here. They are available from the first author.

2.2.2. VICS: errors

The number of errors made by each participant was very low (less than 3.1% on each test section and session). No statistically significant differences were found in the number of errors made at each session, and there was no statistically significant difference in the number of errors made between the first and second exposures to a stimulus. Twenty stimuli had an error rate of greater than 10%.

2.2.3. How similar were the verbal and imagery reaction times overall?

To examine whether participants were showing consistent individual differences in reaction times across each session, each participant's session 1 and session 2 median reaction time on each section of the task (verbal and imagery), and on both stimulus forms (pictures and words), were correlated. The high correlations (all $r > 0.84$) suggest that participants were generally responding with consistent individual differences across each session.

2.2.4. Assessment of verbal–imagery cognitive style preference

To examine whether participants have a verbal or imagery style preference, a measure is required which directly compares each participant's performance on the verbal items to their performance on the imagery items. In other words, the reliability of the medians given above tells us nothing about cognitive style preferences for verbal or imagery processing. To examine verbal–imagery preferences, Riding's (1991) CSA takes a ratio of each participant's average verbal task reaction time to each participant's average imagery task reaction time. Riding does not state what form of average he uses in the CSA's ratio calculation, however the use of the median reaction time seems the most appropriate, as outliers do not affect it as they do the mean. The process of creating a verbal–imagery ratio results in each participant having a score somewhere along a verbaliser–imager continuum. Like the CSA, the VICS test is also designed to investigate whether participants have a verbal task or an imagery task preference. However, the VICS test is also set up to investigate whether participants have a verbal or imagery preference by calculating a ratio in a variety of other ways (e.g., pictures vs words, exposure 1 vs exposure 2, verbal task in words vs imagery task in pictures etc.). This study used a method similar to the CSA, namely a ratio of each participant's median reaction time (RT) on the verbal section overall with each participant's median RT on the imagery test section overall (verbal/imagery ratio).

2.2.5. The reliability of verbal/imagery ratios: is there a stable style preference?

The reliability over time of 11 possible ratios based on the VICS items was investigated. The verbal/imagery ratio was found to be the most stable between session 1 and session 2 ($r_s = 0.62$). The parametric correlation coefficient was somewhat lower ($r = 0.50$). The second most stable ratio over time was the verbal–imagery ratio calculated from responses made during the second exposure only ($r = 0.61$, $r_s = 0.58$).

Participants' verbal/imagery ratios at session 1 and session 2 showed a normal distribution (see Appendix A). This argues against arbitrarily imposing thresholds on these data to allocate people into style types or categories. A scattergram of the verbal/imagery ratios at session 1 and session 2 was also inspected to examine the spread of the data. One participant was an outlier. When this participant was asked whether she did anything different at session 2 that she did not do in session 1, she replied that in session 1 she read each stimulus in her head, translating all words into the picture form, before answering. At session 2 she just looked at the pictures and words and judged them on 'face value'. When this participant was removed and the data were reanalysed, most of the correlations between the ratios increased slightly. For example, the verbal/imagery ratios at session 1 and session 2 increased from $r = 0.5$, $r_s = 0.62$ to $r = 0.56$, $r_s = 0.66$.

For a test to be psychometrically sound it not only needs to be reliable over time but it should also be internally consistent and thereby show period free reliability. To examine whether the VICS test was internally consistent, responses on even and odd items from both the verbal and imagery sections of the test were split. The correlations between the split-half verbal/imagery ratios were high at both session 1 ($r = 0.72$, $r_s = 0.71$) and session 2 ($r = 0.78$, $r_s = 0.76$).

In summary, the analysis of the verbal/imagery VICS ratios indicated that the VICS can detect individual differences in performance on the verbal and imagery tasks and that the most reliable and internally consistent way of measuring this difference is by comparing participants' speed of response on the whole verbal section (word and picture items) of the test with their speed of response on the whole imagery section (words and pictures) of the test. Each of these sections contains an equal number of word and picture-based items. This verbal/imagery ratio was found to have high internal consistency ($r = 0.78$) and acceptable stability between session 1 and session 2 ($r = 0.56$) especially when one participant (an outlier) was removed.

2.2.6. CSA-VI results

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

The reliability of the CSA-VI's style preference ratios over time, on both the original and parallel forms of the CSA-VI, were found to be below acceptable levels for a psychometric test (CSA-VI original $r = 0.31$, $p = 0.04$; CSA-VI parallel $r = 0.06$, $p = 0.71$). Similarly, in keeping with Peterson et al. (2003a), internal consistency of the CSA-VI was measured using split-half reliability analysis. To create enough items for the split-half reliability analysis, the data from the CSA-VI's original and parallel versions were combined and then split into odd and even items. The verbal/imagery ratios from each split half of the combined CSA-VI data were then correlated to look for internal consistency and found to be very poor and not statistically significant at session 1 ($r = 0.03$, $p = 0.863$) and session 2 ($r = -0.11$, $p = 0.465$).

2.2.7. Summary of main findings

Internal consistency of the crucial verbal/imagery ratios on the VICS test was high and the verbal/imagery ratios at re-test on the VICS were also stable across about a week. In contrast, and in keeping with Peterson et al. (2003), the internal consistency of the combined CSA-VI was low and non-significant and the verbal/imagery ratio at re-test on the CSA-VI was also below acceptable levels for a psychometric test ($r = 0.31$, $p = 0.037$).

3. Experiment 2

Experiment 2 was conducted in an attempt to replicate the main findings of Experiment 1 on an independent, larger sample of 100 participants. Participants were mostly first year psychology students at the University of Edinburgh and all spoke English as their first language (age $M = 20$ years, SD = 4.1, range 18–57).

The experiment design, procedure and stimulus materials were the same as in Experiment 1 with three exceptions. First, the second session was administered over a wider time frame (mode = 7 days, range 7–182). Second, only the original verbal–imagery dimension of the CSA was administered (the parallel version of the CSA-VI was not used). Third, 11 changes were made to the VICS test stimuli. Changes were made only to stimuli that were found in Experiment 1 to have an error rate of more than 11% on any one session. Some items with lower error rates were also changed in order to create new pairs, but no new objects were employed.

3.1. Results

The number of errors in the VICS test made by each subject at each session was low (less than 3% on both tasks and at each session). Only nine stimuli resulted in an error rate of greater than 10% at each session, half the number of Experiment 1.

Table 2 provides a summary of the reliability and internal consistency results of the verbal–imagery style ratios from the VICS and the CSA-VI in the sample of 50 participants from

Table 2
Reliability and internal consistency (both Pearson's *r*) of the CSA's original verbal–imagery dimension, the double-length (extended) version of the CSA's verbal–imagery dimension and the VICS test

Test	Experiment[b]	No. in sample	Reliability	Internal consistency (at session 1)
CSA original	Peterson et al. (2003a)	50	0.201 (ns)	[a]
	Experiment 1	50	0.302	[a]
	Experiment 2	100	0.085 (ns)	[a]
Extended CSA	Peterson et al. (2003a)	50	0.266 (ns)	0.292
(CSA-A & CSA-B)	Experiment 1	50	0.174 (ns)	0.025 (ns)
VICS Test	Experiment 1	50	0.564	0.720
	Experiment 2	100	0.549	0.885

ns = non-significant result at $p > 0.05$.
[a] There are insufficient items in the original CSA to calculate internal consistency.
[b] Experiments 1 and 2 refer to those in the present study.

Experiment 1 and this further sample of 100 participants in Experiment 2. For comparison, Table 2 also includes the CSA-VI and reliability data collected during an earlier study by Peterson et al. (2003a). The results from this sample of 100 confirm those from the first experiment's 50 and from the earlier study, in that the internal consistency of the VICS test style ratio remains high ($r = 0.89$, $p < 0.001$) and the test re-test reliability of the VICS appears moderately stable ($r = 0.55$, $p < 0.001$). The CSA-VI test re-test reliability falls to below acceptable levels for a psychometric test ($r = 0.09$, ns). Internal consistency correlations are not reported for the CSA-VI in the sample of 100 as there were not enough items to calculate this measure satisfactorily.

3.2. Discussion

This study has reported the construction, development and testing of a new test of individual differences in verbal–imagery cognitive style (VICS test). In a total sample of 150 participants, the VICS test is internally consistent and moderately reliable. The verbal–imagery dimension of the popular CSA test lacks these psychometric properties. These findings suggest that the psychometric properties and the validity of the VICS warrant further investigation, whereas the CSA-VI role in cognitive style testing needs to be reviewed. Having developed the VICS test, we found that the VICS test's structure and design also met seven out of the eight recommendations made by Rezaei and Katz (2004) for a new verbal–imagery cognitive style test. This provides further support for the development, structure and design of the new VICS test.

There is a considerable amount of research that still needs to be conducted on the VICS test. Now that we have established the VICS test's reliability we can begin to investigate the VICS test's validity. Research on the VICS test needs to be conducted in five main areas: (1) the nature of the test elements that lead to stable individual differences being measured; (2) the cognitive processes underlying individual differences in reaction times; (3) the relationship that the VICS test has with existing neurocognitive and cognitive models; (4) the VICS test's potential applications to areas such as education, management, training and multimedia design and (5) the independence of the VICS test from other related measures. Research on the latter has already shown that the

VICS test is largely independent of personality and ability (Peterson, Deary, & Austin, submitted).

In conclusion, this study has presented a new test of verbal–imagery cognitive style (VICS test) which is more internally consistent and reliable than the popular verbal–imagery dimension of the CSA, whose internal consistency and reliability are unsatisfactory even when the test is doubled in length. Although more research is needed on the VICS test, this should not detract from the main and novel finding that we have designed a new test that measures stable individual differences on ratios on a verbal–imagery task. Now we need to find out more about the nature and causes of these differences and whether they can be applied to help increase our understanding of other psychological fields.

Acknowledgements

This project was supported by the New Zealand Foundation for Research in Science and Technology and the United Kingdom Economic and Social Research Council.

Appendix A

See Figs. 5 and 6.

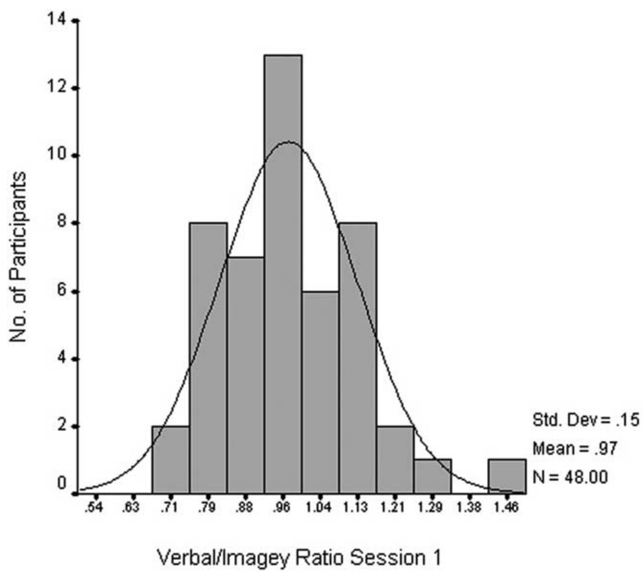

Fig. 5. Histogram of the verbal–imagery ratio on the VICS test at session 1.

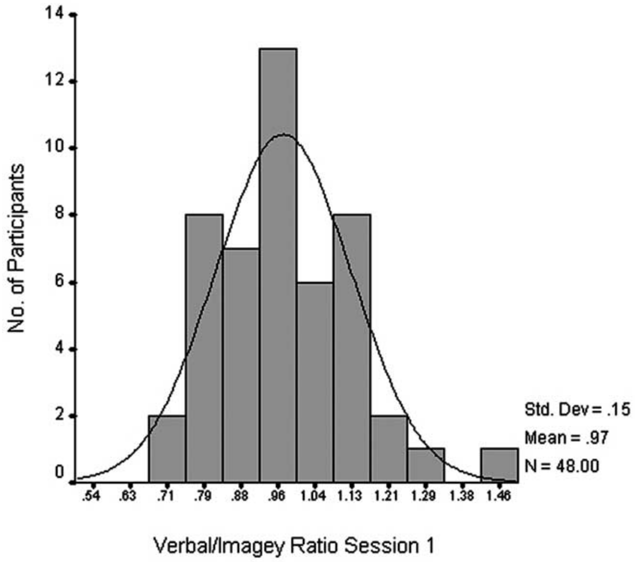

Fig. 6. Histogram of the verbal–imagery ratio on the VICS test at session 2.

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