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Do age and gender make a difference in the relationship between intellectual styles and abilities?

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Abstract This article reports two studies that aim at further distinguishing intellectual styles from abilities by taking into account the confounding effects of age and gender on the relationship between these two constructs. Two independent groups of secondary school students responded to the *Thinking Styles Inventory-Revised* and took the *Sternberg Triarchic Abilities Test (Level H)*. Both sets of results suggested that although statistically significant relationships could be identified between thinking styles and abilities, when age and gender were put under control, styles and abilities became fundamentally independent. Implications of this finding for students and teachers are discussed.

Résumé La présente contribution propose de discuter deux études dont l'objectif était d'élargir la différenciation entre styles intellectuels et habiletés en prenant en compte les effets complexes de l'âge et du sexe dans la relation entre ces deux concepts. Deux groupes indépendants de lycéens ont été interrogés sur deux types de questionnaires : *Thinking Styles Inventory-Revised* et *Sternberg Triarchic Abilities Test (Level H)*. Les résultats montrent que même si un certain nombre de relations peuvent s'établir statistiquement entre styles intellectuels et habiletés, lorsque l'âge et le sexe deviennent les facteurs dominants, les styles et les habiletés deviennent fondamentalement indépendants. Dans cette présentation, nous analyserons les implications de cette recherche pour les enseignants et les apprenants.

Keywords Abilities · Age · Gender · Intellectual styles · Thinking styles

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Introduction

General background

Intellectual styles, an encompassing term for such constructs as cognitive styles, learning styles, and thinking styles, refer to people's preferred ways of processing information and dealing with tasks (Zhang and Sternberg 2006). Many enlightening works on intellectual styles have been published over the past eight decades or so (e.g., Klein 2003; Kozhevnikov 2007; Messick 1994; Riding and Rayner 1998). However, the value of studying styles has not gone unquestioned (e.g., Coffield et al. 2004a, b; Tiedemann 1989). Between the late 1970s and mid-1980s, the field of intellectual styles experienced a severe setback due to several reasons, one of which being that early theories presented styles that could not be proven to be "pure" style constructs (Sternberg 2001). These styles were not clearly distinguishable from abilities nor from personality traits. Consequently, the study of styles was easily immersed into the investigation of abilities or of personality traits and the need for a distinct area of research on styles seemed to no longer exist. In fact, some critics of the concept of styles (e.g., Cronbach and Snow 1977; Hunt and MacLeod 1978) asserted that individual differences in performance are mostly attributed to general abilities, but not to styles.

Importance of distinguishing styles from abilities

However, studying the distinctions between styles and abilities remain important because abilities can only partially explain individual differences in human performance such as students' academic achievement (McDermott 1984). At the same time, it has been repeatedly found that styles are just as important as abilities in accounting for individual differences in human performance (e.g., Mansfield et al. 1997). For example, when studying the interrelationships among intelligence, field independence, and achievement in mathematics among 201 school boys, Satterly (1976) found that the field-independent style significantly contributed to students' math achievement, as did students' intelligence. Moreover, from the perspective of educational practice, achieving a clear understanding of the differences between styles and abilities may help both teachers and students in their teaching and learning. For example, traditionally, teachers and students have believed that students' successes and failures are attributable mainly to students' individual differences in abilities. Understanding the distinction between abilities and styles may enable teachers and students to start seeking alternative explanations for students' successes and failures, such as looking into individual differences in students' learning styles. Therefore, over the years, advocates for the unique value of intellectual styles have done much, at both the conceptual and empirical levels, to differentiate styles from abilities (e.g., Armstrong 2000; Messick 1996; Tullett 1997).

Existing work on style-ability similarities and differences

At the conceptual level, both similarities and differences between the two constructs have been elaborated. One of the earliest discussions on the basic distinctions between abilities and styles can be found in Witkin and colleagues' work (Witkin et al. 1977). Witkin's group differentiated the two constructs by emphasizing the unipolar nature of abilities (measured from low to high, with the high end being preferred, regardless of the situation) in contrast to the bipolar nature of styles (also measured from low to high, but with both ends having

an equal chance of being preferred, depending on the stylistic demands of a specific situation). Messick (1996) noted that one of the major distinctions between abilities and styles is that the former pertain to how much and the latter are relevant to how. To these scholars, what abilities and styles have in common is that they both contribute to human performance.

At the empirical level, complex relationships have been found between abilities (often used interchangeably with intelligence) and styles. Some studies resulted in either nonsignificant relationship or statistically significant relationships that were contrary to expectations. For example, Mehdi (1974) reviewed the literature on the relationships between intelligence and the two types of thinking proposed by Guilford (1950, 1967) in his model of the "structure of intellect." These are convergent thinking and divergent thinking. The convergent–divergent thinking construct has been conceptualized as one of the key style constructs in Zhang and Sternberg's (2005) *Threefold Model of Intellectual Styles*. Convergent thinking refers to the reproduction of ideas and facts directly from known information. Divergent thinking involves the generation of new ideas that minimally depends on known information. In the studies reviewed by Mehdi, the convergent–divergent thinking construct was usually assessed by several types of tools, including word association (a test in which the research participant is required to give as many definitions as possible of a rather common word such as a bolt or a sack), uses of things (a test in which the research participant is required to give as many uses as he/she can for a common object, such as a brick or toothbrush), and fables test (a test in which the research participant is presented with short fables from which the last line is missing; the research participant is asked to compose three different endings for each fable—a moralistic one, a humorous one, and a sad one). Intelligence was most commonly assessed by traditional IQ tests. The author concluded that contrary to expectations, those individuals who are divergent in their thinking are not necessarily those who are highly intelligent.

More recently, Armstrong (2000) examined the relationship between cognitive styles and overall ability among business and management students in England. Cognitive styles were measured by Allinson and Hayes' (1996) *Cognitive Style Index*, while overall ability was represented by students' final degree grades. As expected, students higher on the analytic style obtained better grades for long-term solitary tasks, involving careful planning and analysis of information. However, contrary to expectations, students scoring higher on the analytic style also achieved better on tasks that were believed to be more suitable for students higher on the intuitive cognitive style as well as on the overall ability. That is to say, styles and abilities were not related in the expected directions.

Other studies suggested that abilities/intelligence and styles interact. For example, Messer (1976) reviewed studies reporting correlations between reflective/impulsive styles (also known as conceptual tempo) as measured by the Matching Familiar Figures Test (Kagan et al. 1964) and intelligence test scores. Conceptual tempo defines an information-processing continuum that is most prominent in children. It is represented by two opposing styles: reflective and impulsive. People with a reflective style tend to consider and reflect on alternative possible solutions before they respond to a problem. People with an impulsive style tend to come up with a solution without sufficient forethought. Messer (1976) asserted that conceptual tempo is moderately correlated with intelligence only when levels of intelligence fall within the normal range.

These inconsistent findings on the relationships between abilities and styles call for further investigation of this topic. In particular, it is believed that future studies should overcome at least two weaknesses in previous ones. First, the majority of the previous studies were conducted more than two decades ago and they are largely based on traditional

theoretical models. "Traditional theoretical models" in the context of the styles literature refer to style models that address one style dimension with bipolar terms such as field-dependent style versus field-independent style and impulsive style versus reflective style. In the context of the abilities/intelligence literature, "traditional theoretical models" refer to intelligence/ability models that merely pertain to analytical/reasoning abilities. Yet, in reality, neither styles nor abilities are uni-dimensional. Therefore, future studies should adopt style models that address more than one style dimension and intelligence models that go beyond analytical/reasoning abilities.

Secondly, in previous studies of the association between abilities and styles, the most basic variables such as people's age and gender that could confound the relationship between styles and abilities have not been given the attention they deserve. It is true that as a rule, both preferences as represented by styles and capacities as represented by abilities vary within the human population. However, as evidenced in numerous research findings (e.g., Bell et al. 1972; Cheung 2002; Edmunds 1990; Zhang and Sachs 1997), age and gender can account for significant amounts of variations in both styles and abilities.

The effects of age on people's abilities have long been established. For example, early in 1958, Wechsler concluded that people's abilities generally grow as a function of age until they reach a plateau or even decline at old age. Evidence for significant gender differences in various abilities has also been well documented in the literature. For example, numerous studies have concluded that men tend to demonstrate higher levels of spatial abilities than women (e.g., Bosco et al. 2004). Likewise, empirical findings for the effects of gender and age on styles are also abundant. For example, when examining Kolb's (1976) learning styles among students, Titus (1990) found that females tended to be more concrete than their male counterparts. After investigating gender difference in Gregorc's (1979) learning styles, Davenport (1986) reported that males showed a stronger preference for the abstract sequential learning style and females a stronger preference for the abstract random style. In a like vein, many authors have found a general change in intellectual styles with age. For example, putting Gurley's (1984) and Witkin et al. (1971) work together, Jonassen and Grabowski (1993) portrayed the following picture of the growth curve of field-dependence/independence: In general, children are more field dependent and their field independence increases as they grow into adulthood. Adults, especially adult learners, are the most field independent. From that point in time on, people's field independence decreases throughout the rest of their lives, with older people the most field dependent.

To summarize, although the distinctions between intellectual styles and abilities have been clearly delineated at the conceptual level, research findings on the relationships between the two constructs have been complex and inconsistent. One of the reasons for the inconsistent findings could well be that previous research did not take into account the effects of age and gender on the relationships between styles and abilities. As reviewed above, age and gender do affect both abilities and styles. It is, therefore, the intention of the present research to examine the main research question: "Do age and gender make a difference in the relationship between intellectual styles and abilities?"

Conceptual framework

Containing two studies (one serving as an initial exploration and the other serving as a cross validation), the present research intends to further disentangle styles from abilities. It takes two strategies to overcome the limitations of previous studies. First, it employs a style construct that has been claimed to be more general—thinking styles as defined in

Sternberg's (1988, 1997) theory of mental self-government and an ability construct that goes beyond analytical/reasoning ability—Sternberg's (1985, 1996) triarchic abilities. Sternberg's notion of thinking styles is regarded as a more general and parsimonious style construct because it has conceptually and empirically brought together various style constructs (e.g., cognitive style, learning style, mind style, and so forth) proposed in the past several decades (Zhang and Sternberg 2005). Second, this research examines the confounding effects of both age and gender upon the relationship between styles and abilities.

The theory of mental self-government and its research

Sternberg (1988, 1997) contended that just as there are different ways of governing a society, there are different ways that people use their abilities. These preferred ways of using one's abilities are considered "thinking styles." According to Sternberg, there are 13 thinking styles that fall along five dimensions: function, form, level, scope, and leaning. Based on empirical data, Zhang and Sternberg (2005) reconceptualized the 13 styles into three types.

Type I thinking styles tend to be more creativity-generating and they denote higher levels of cognitive complexity, including the legislative (being creative), judicial (evaluative of other people or of products), hierarchical (prioritizing one's tasks), global (focusing on the general picture), and liberal (taking a new approach to tasks) styles. Type II styles suggest a norm-favoring tendency and they denote lower levels of cognitive complexity, including the executive (implementing tasks with specific instructions), local (focusing on details), monarchic (working on one task at a time), and conservative (using traditional approaches to tasks) styles. Type III styles, including the anarchic (working on whatever tasks that come along), oligarchic (working on multiple tasks with no priority), internal (working on one's own), and external (working with others) styles, may manifest the characteristics of the styles from both Type I and Type II groups, depending on the stylistic demands of a specific task.

Much empirical evidence has supported the validity of Sternberg's original theory as well as its reconceptualized notion of three types of thinking styles (Kaufman 2001; Zhang 2005). The most frequently used testing tool is the Thinking Styles Inventory (TSI, Sternberg and Wagner 1992) and its revised version—the *Thinking Styles Inventory-Revised* (TSI-R, Sternberg et al. 2003). Research using these inventories suggests that thinking styles vary as a function of both personal characteristics (e.g., age and gender) and environmental characteristics (e.g., nature of academic discipline). This research also indicates that, in general, thinking styles make a difference in students' school performance (e.g., Grigorenko and Sternberg 1997; Zhang 2004c) and in teachers' teaching (Zhang and Sternberg 2006). More importantly, such evidence has been obtained in many parts of the world, including Asia (Bernardo et al. 2002; Park et al. 2005), Europe (e.g., Betoret 2007; Cano-Garcia and Hughes 2000), and North America (e.g., Dai and Feldhusen 1999; Grigorenko and Sternberg 1997). Furthermore, existing experimental research has revealed that teaching that takes thinking styles into account makes a significant difference in students' academic performance (e.g., Fan 2006). Finally, the Thinking Styles Inventory has been tested with other well-established inventories that measure intellectual styles, including the Group Embedded Figures Test (Witkin et al. 1971; see Zhang 2004b) and the Style of Learning and Thinking (Torrance et al. 1988; see for example, Zhang 2002).

However, efforts in differentiating these styles from abilities have been rare. A thorough literature search resulted in merely three such studies. In studying Chinese university

students, Fan (2006) and He (2005) each examined the relationship between thinking styles in Sternberg's theory and students' scores on the Advanced Progressive Matrices (Raven 1998). Each of these two studies resulted in merely one significant correlation coefficient out of the 13 correlations. Thus, both studies concluded that essentially, there was little association between thinking styles and ability.

However, the questions that arise are: "Could this general lack of relationship between thinking styles and ability be due to the fact that the Raven ability test only assesses general ability? Would significant results emerge if thinking styles are tested against an ability measure that assesses more specific aspects of students' abilities?" Grigorenko and Sternberg (1997) tested these thinking styles against three aspects of ability/intelligence to be described in what follows.

The triarchic theory of intelligence and its research

According to Sternberg (1985, 1996), intelligence is composed of three aspects: analytical abilities, creative abilities, and practical abilities. Analytical abilities emphasize information processing of the human mind. Creative abilities relate to how human beings' prior experience may interact with the analytical aspect of intelligence in dealing with novel situations. Practical abilities involve individuals applying their abilities to the kinds of problems that confront them in daily life.

The main assessment tool for testing the three aspects of intelligence is the Sternberg Triarchic Ability Test (STAT, Sternberg 1993; see "Method" section). Studies carried out in several cultures (e.g., Finland, Hong Kong, Spain, and the United States) yielded reasonably good overall internal scale alpha coefficients and supported both the structural and external construct validity of the STAT (e.g., Sternberg 1999; Sternberg et al. 2001; Sternberg and Grigorenko 2007; Zhang 2004c). It has also been found that students' STAT scores were significantly related to their academic performance (e.g., Koke and Vernon 2003).

Furthermore, as previously mentioned, an effort has been made to distinguish thinking styles from the triarchic abilities. Grigorenko and Sternberg's (1997) study of American high school students showed a general lack of association between thinking styles and abilities: only one statistically significant relationship was found among the 39 possible relationships (i.e., three kinds of abilities by 13 thinking styles).

The finding of Grigorenko and Sternberg was consistent with that obtained by Fan (2006) and He (2005) who tested thinking styles with Raven's ability test. Therefore, the existing studies reached the same conclusion: that styles and abilities are essentially independent of each other. However, none of the three studies has proved the null hypothesis on the relationship between styles and abilities.

The present research

The present research continues to explore the relationship between thinking styles and the triarchic abilities. It examines this relationship among Hong Kong secondary school students, taking into account students' age and gender. The need for taking age and gender into consideration arose from the fact that although no significant difference in the triarchic abilities has been reported for age and gender, previous research has found that both age and gender could make a difference in thinking styles (Cheung 2002; Zhang and Sachs 1997). For example, Zhang and Sachs' (1997) study suggested that Hong Kong male university students scored higher on the global style than did their female counterparts. This gender difference has been supported by the results of Cheung's (2002) study of secondary

school students in Hong Kong. The two aforementioned studies have also identified that older participants tended to score lower on Type I thinking styles. Such variations in thinking styles as a function of age and gender would necessarily obscure the true relationship of thinking styles to other human attributes, including abilities. Therefore, in the present research, an effort was made to remove the potential effects of age and gender on the relationships between thinking styles and abilities. It was hypothesized that age and gender have a confounding effect on the relationship between styles and abilities.

Method

Participants

In Hong Kong, secondary schools are classified into three bands, with the top one-third of primary school graduates being admitted to Band One secondary schools and the bottom one-third being admitted to Band Three schools on the basis of their academic achievement. Data were initially gathered among students in a Band One school. The concern over the limited generalizability of the results from students of relatively high homogeneity regarding academic ability levels led to the second data collection—that from students in Band Two and Band Three schools.

Study 1 Participants in Study 1 were 242 (128 boys and 114 girls) students from a Band One school. Of all the participants, 85 were studying in Form 1 (equivalent of Grade 7), 77 in Form 2 (Grade 8), and 80 in Form 3 (Grade 9). With an average age of 14 years, the participants' ages ranged from 12 to 16 years.

Study 2 Participants in Study 2 were 337 (165 boys and 172 girls) students from two (one Band Two and one Band Three) schools. Of these participants, 81 were studying in Form 2, 91 in Form 3, 83 in Form 4, and 82 in Form 5. With an average age of 15 years, the participants' ages ranged from 12 to 17 years.

Measures

The research participants in both studies took two measures. The first was the *Thinking Styles Inventory–Revised* (TSI-R; Sternberg et al. 2003). The second was the Sternberg Triarchic Abilities Test (STAT; Sternberg 1993).

Thinking Styles Inventory–Revised The *Thinking Styles Inventory–Revised*, a self-report test, is a modified version of Sternberg and Wagner's (1992) *Thinking Styles Inventory* (TSI). Consisting of 65 statements, the inventory assesses the 13 thinking styles delineated in the theory of mental self-government. For each statement, the participants rated themselves on a 7-point Likert scale, with 1 indicating that the statement does not at all represent the way they normally carry out their tasks and 7 denoting that the statement characterizes extremely well the way they normally carry out their tasks. Here are two examples: (1) "When faced with a problem, I use my own ideas and strategies to solve it" (legislative style) and (2) "I like to figure out how to solve a problem following certain rules" (executive style).

The TSI-R has been used in four previous studies: Zhang's (2004a) study of Beijing university students, Zhang's (2004d) study of Hong Kong university students, Zhang's (2005) study of mainland Chinese business personnel, and Zhang and Higgins's (2008)

study of British business personnel. Consistently, good validity data for the inventory were obtained. Likewise, in all four studies, dramatic improvement was manifest in the internal scale reliability for two of the three revised scales (local and monarchic). However, not much improvement has been shown for the anarchic scale. Table 1 lists the Cronbach alpha coefficients from these studies.

In the present research, the alpha coefficients (see also Table 1) obtained for the TSI-R scales ranged from 0.41 (anarchic style) to 0.82 (liberal style), with a median of 0.71 (legislative and conservative styles) for Study 1. For Study 2, the alpha coefficients (see also Table 1) ranged from 0.50 (again, anarchic style) to 0.83 (liberal and legislative styles), with a median of 0.75 (conservative style). These alpha coefficients are comparable in magnitude to those reported in the four existing studies.

Sternberg Triarchic Ability Test The STAT (Sternberg 1993) is a performance test measuring the analytical, creative, and practical abilities proposed in Sternberg's (1985) triarchic theory of human intelligence. Level H of the STAT, used in the present research, was developed for secondary/high school and university students. The test measures performance in three domains (also known as three relatively independent intellectual mental representations, see Burt 1940; Vernon 1971)—verbal, quantitative, and figural. The use of a variety of domains, according to Sternberg (1999), was intended to ensure that students who do well on one particular form of representation but not on another will nonetheless be provided with the opportunity to show their abilities.

The 36 items in the multiple-choice test are distributed into nine scales (three kinds of abilities by three domains), with each scale containing four items. These nine scales are: (1) analytical-verbal (dealing with artificial words), (2) analytical-quantitative (number series), (3) analytical-figural (matrices), (4) practical-verbal (everyday reasoning), (5) practical-quantitative (everyday math), (6) practical-figural (route planning), (7) creative-verbal (novel analogies), (8) creative-quantitative (novel number operations), and (9) creative-figural (novel series completions).

Table 1 Scale reliability for the *Thinking Styles Inventory-Revised*

Scale	Zhang 2004a (N=348)	Zhang 2004d (N=255)	Zhang 2005 (N=333)	Zhang and Higgins (2008) (N=117)	The Present Research Study 1 (N=242)	The Present Research Study 2 (N=337)
Legislative	0.74	0.80	0.78	0.69	0.71	0.78
Executive	0.65	0.69	0.60	0.78	0.63	0.80
Judicial	0.74	0.83	0.71	0.74	0.74	0.80
Global	0.65	0.61	0.70	0.62	0.60	0.70
Local	0.67	0.72	0.69	0.69	0.68	0.69
Liberal	0.83	0.88	0.82	0.82	0.82	0.83
Conservative	0.76	0.79	0.77	0.87	0.71	0.75
Hierarchical	0.75	0.77	0.77	0.63	0.77	0.80
Monarchic	0.65	0.70	0.68	0.74	0.70	0.68
Oligarchic	0.70	0.72	0.71	0.73	0.63	0.66
Anarchic	0.51	0.52	0.55	0.32	0.41	0.50
Internal	0.73	0.83	0.75	0.68	0.79	0.83
External	0.78	0.82	0.71	0.73	0.75	0.73

As noted earlier, several studies using the STAT have resulted in good internal scale reliability and have supported its validity for assessing the triarchic abilities among students in several cultures. The overall coefficient alpha reliability was 0.82 for the US sample, 0.67 for the Finnish sample, 0.82 for the Spanish sample, and 0.74 for the Hong Kong sample. Students' scores on the STAT tests were correlated with scores on academic assessments tapping memory, analytical, creative, and practical components, as well as their results on other measures of mental abilities (e.g., the *Terman Concept Mastery Test* [Terman 1956] and the *Cattell Culture Fair test of g* [Cattell and Cattell 1959]) that were intended to evaluate both more conventional analytical thinking abilities and reasoning abilities for dealing with novel tasks (Sternberg and Clinkenbeard 1995).

The present research used a Chinese version of the inventory that was translated and back-translated between Chinese and English for a previous study of Hong Kong school students (Zhang 2004c). Although the overall coefficient alpha for Zhang's study was 0.74, Cronbach's alphas were 0.60, 0.34, and 0.66, respectively, for the analytical, practical, and creative ability scales. Whereas the reliability data for the analytical and creative scales were considered acceptable, the reliability for the practical ability scale was deemed too low in Zhang's study to allow for further data analyses.

Despite its low internal reliability in an earlier study, the author did want to use the practical scale in the present research for two major reasons. First, the STAT had been proofed to be a reliable and valid inventory for assessing all three kinds of abilities defined in Sternberg's theory in countries outside the United States, such as Finland and Spain (see earlier review). Second, Zhang's (2004c) study was the first that had used the STAT among Hong Kong Chinese students. As such, one was not able to determine the real cause of the low scale reliability. It is possible that the practical scale was truly unreliable for measuring the practical ability of Hong Kong Chinese secondary school students. However, it is equally possible that the low reliability of the practical scale was due to sampling bias or to any other chance variance. Therefore, the present research employed the same version of the STAT inventory as that in Zhang's earlier study, without any modification. One of the advantages of administering the same inventory to additional samples (such as in the case of the present research) is that the results from new data may serve either as a validation or as a negation of previous findings.

In the present research, the overall coefficient alpha is 0.75 in Study 1 and 0.81 in Study 2. However, Cronbach's alphas are 0.65, 0.35, and 0.67, respectively, for the analytical, practical, and creative scales in Study 1 and 0.68 (analytical), 0.37 (practical), and 0.72 (creative) in Study 2. Like in Zhang's (2004c) study, the internal scale reliability for the practical scale in both studies was too low to be included for further data analyses. Such consistently low reliability data obtained for the practical scale indicate that items in the practical scale that were originally constructed to assess practical intelligence (ability) among US students may not be suitable for assessing Chinese students' practical intelligence. What constitutes intelligence is, in general, culture bound. Practical intelligence, in particular, is subject to cultural interpretations (Sternberg 1999, 2004). Therefore, the STAT items meant to evaluate the practical aspect of ability/intelligence require further modification and testing among Hong Kong secondary school students.

Data analysis

A preliminary statistical analysis (using zero-order correlations) was performed to test the relationships of age and sex to thinking styles and abilities. To identify whether or not age and gender have confounding effects on the relationship between thinking styles and

abilities, two statistical procedures were applied to data in each study, respectively. First, zero-order correlation coefficients between the two sets of scales (one containing the 13 thinking styles and the other being the analytical and creative abilities) were calculated. Second, partial correlation coefficients (with age and gender being controlled for) were computed for the two sets of scales. The rationale for selecting these statistical procedures is as follows:

Given that previous research results on the relationships between styles and abilities have been equivocal, zero-order correlations were initially calculated to explore the basic relationships between these two main constructs in this research. Although the relationships between abilities and thinking styles are statistically significant, they are weak. Such weak statistical relationships required that only a somewhat more stringent statistical procedure (i.e., partial correlation) be used, rather than the more stringent statistical procedures such as hierarchical multiple regressions, multivariate analyses of variance, and analyses of covariance.

Results

Relationships of age and gender to thinking styles and abilities

The relationships of age and gender to thinking styles and abilities for Study 1 and Study 2 are represented by the zero-order correlation coefficients in Table 2, with age and gender

Table 2 Zero-order correlation coefficients: Age and gender with abilities and thinking styles ($N_{\text{Study 1}}$=242; $N_{\text{Study 2}}$=337)

	Study 1		Study 2	
Scale	Age	Gender[a]	Age	Gender[a]
Abilities				
Analytical	0.28***	−0.42***	0.63***	−0.66***
Creative	0.29***	−0.40***	0.42***	−0.34***
Thinking styles				
Legislative	0.06	−0.19**	0.10	−0.12*
Executive	−0.10	−0.09	−0.07	−0.07
Judicial	0.01	−0.18**	−0.13*	−0.10
Global	−0.18**	−0.10	−0.15*	−0.13*
Local	0.08	−0.03	0.13*	0.01
Liberal	−0.06	−0.18**	−0.25**	−0.26**
Conservative	−0.08	−0.12	0.13*	−0.01
Hierarchical	−0.10	−0.09	0.15*	−0.06
Monarchic	−0.04	−0.14*	0.04	−0.08
Oligarchic	−0.00	−0.06	0.13*	−0.04
Anarchic	−0.01	−0.05	−0.03	−0.06
Internal	0.19**	−0.17**	0.21**	−0.23**
External	−0.16*	−0.06	0.18**	0.08

*p<0.05; **p<0.01; ***p<0.001

[a] Male was coded as "1" and female was coded as "2"

being one set of variables and thinking style and ability scales being the other. In both samples, older students and male students scored significantly higher on both analytical and creative abilities than did younger and female students. Also in both samples, female and older students tended to score significantly lower on the Type I thinking styles.

Zero-order correlation coefficients between thinking styles and abilities

The zero-order correlation matrix for Study 1 showed that ten of the 26 correlation coefficients (13 styles by two ability scales) were statistically significant. Essentially, Type I styles and the internal style were significantly correlated with both analytical and creative abilities (see Table 3).

The zero-order correlation matrix for Study 2 resulted in 17 statistically significant correlations. The two ability scales were correlated with a wide range of styles (see Table 4).

Partial correlation coefficients between thinking styles and abilities

Results from Study 1 suggested that after age and gender were controlled for, only one of the 26 correlation coefficients between thinking styles and abilities was statistically significant (see also Table 3). In Study 2, three of the partial correlation coefficients were statistically significant (see also Table 4).

Discussion

The aim of this research was to examine the relationship between thinking styles and abilities. Zero-order correlation coefficients revealed that, in general, there was a significant

Table 3 Zero-order and partial[a] correlations coefficients (Study 1): Thinking styles and abilities (analytical and creative)

Scales	Analytical	Analytical[a]	Creative	Creative[a]
Legislative	0.16*	0.05	0.14*	0.03
Executive	0.09	0.07	0.05	−0.01
Judicial	0.14*	0.04	0.15*	0.11
Global	0.14*	0.11	−0.02	−0.06
Local	−0.03	−0.04	0.09	0.11
Liberal	0.15*	0.12	0.16*	0.12
Conservative	0.07	0.05	0.04	0.00
Hierarchical	−0.02	0.02	−0.05	−0.05
Monarchic	0.05	0.00	0.08	0.03
Oligarchic	0.05	−0.01	0.10	0.05
Anarchic	0.00	0.02	0.15*	0.16*
Internal	0.20**	0.08	0.14*	−0.04
External	−0.01	0.03	−0.01	0.05

*$p<0.05$; **$p<0.01$

[a] Age and gender were controlled for

Table 4 Zero-order and partial[a] correlations coefficients (Study 2): Thinking styles and abilities (analytical and creative)

Scales	Analytical	Analytical[a]	Creative	Creative[a]
Legislative	0.17*	0.14	0.17*	0.12
Executive	0.04	0.02	0.05	0.02
Judicial	0.35**	0.22*	0.07	0.06
Global	0.34**	0.23*	0.20**	0.11
Local	0.08	0.04	0.20**	0.10
Liberal	0.20*	0.11	0.23**	0.16
Conservative	0.18*	0.16	0.09	0.07
Hierarchical	0.41**	0.17	0.09	0.10
Monarchic	−0.03	−0.08	0.12	0.02
Oligarchic	0.18*	0.14	0.20*	0.15
Anarchic	0.27**	0.16	0.23**	0.16
Internal	0.27**	0.17	0.13	0.04
External	0.18*	0.12	0.22**	0.22*

*$p<0.05$; **$p<0.01$

[a] Age and gender were controlled for

relationship between styles and abilities, although fairly weak in Study 1 and somewhat stronger in Study 2. In Study 1, of the ten statistically significant correlation coefficients obtained, nine were merely significant at the most lenient statistical level ($p<0.05$). However, in the Study 2, nine of the 17 statistically significant correlations were obtained at a somewhat more stringent statistical level ($p<0.01$). Across the two studies, these results indicated that students who had a predilection for using a variety of thinking styles, especially those who tended to use creativity-generating (Type I) thinking styles, were most likely to demonstrate higher analytical and creative abilities, at least as manifested by their STAT test scores.

However, are these statistically significant correlations strong enough to make any practical sense? Could these relationships be an artifact of students' demographic characteristics? As reviewed earlier, age and gender may have significant effects on both styles and abilities. Research participants in both studies were composed of roughly 50% boys and 50% girls and their ages somewhat varied. Therefore, a question arises with respect to whether or not students' age and gender had confounded the relationship between their thinking styles and abilities.

Not unexpectedly, when students' age and gender were put under control, the number of the significant correlations was dramatically reduced and so was the magnitude of these correlations. In Study 1, only one of the ten statistically significant correlation coefficients remained significant, but merely at the 0.05 statistical level. In Study 2, only three of the 17 coefficients remained significant, again at the 0.05 statistical level. The disappearance of the remaining previously statistically significant correlation coefficients under the more stringent statistical procedure (partial correlations) suggests that age and gender do make a difference in the relationship between thinking styles and abilities. When age and gender were taken into account, thinking styles and abilities became fundamentally unrelated.

Although like the previous three studies (Fan 2006; He 2005; Grigorenko and Sternberg 1997), the present research failed to prove null relationship between thinking styles and

abilities, it supported the conceptual argument and previous empirical finding that styles and abilities are essentially independent. Especially, the present research took age and gender into account and it obtained consistent results from the two studies involving students from a wide range of academic abilities (all three bands in Hong Kong).

One would argue that such a finding should not be surprising given that the principal characteristics of styles differ from those of abilities, as previously discussed in the literature review. However, the major contribution of this research does not lie in its conclusion that styles and abilities are essentially independent, but rather, in its partial explanation to the existing equivocal findings regarding the relationships between intellectual styles and abilities. That is, significant relationships between the two constructs found in previous studies could have been attributable to the influence of age and gender. Of course, there could be many other variables that create artifacts in the relationships between the two constructs. A true understanding of this relationship calls for an enduring and rigorous research agenda.

Limitations and implications

Obviously, there are at least three major limitations to this research. The first concerns the fact that one of the three ability scales (practical scale) was not usable due to its low reliability. Practical ability is necessarily a different kind of ability from analytical and creative abilities. Had the relationship between thinking styles and practical ability been tested, would the general finding of this research still stand? An answer to this question calls upon future studies that employ an improved version of the STAT (especially improvement in the reliability of the practical scale).

Related to the first limitation, the second one is the fact that the STAT has not been examined together with any of the more widely accepted measures of intellectual abilities. Such testing would have given a clearer indication for the validity of the STAT.

The third limitation of this research pertains to its insufficient control of variables that could also have confounded the relationships between abilities and styles and thus, to the limited generalizability of the present findings. For example, although this research has taken age and gender into account, it has not taken into consideration other important factors such as socioeconomic status, social and cultural environments, and geographical locations that may have great impact on the relationships between abilities and styles. Also for example, would the same results be obtained had the research involved a larger age gap or been extended to the primary school level? All of these are worth serious considerations in future research.

Regardless of these limitations, the present research has made a significant contribution to the long-standing inquiry into the relationship between styles and abilities. That is, by revealing the effects of age and gender on the relationships between thinking styles and abilities, this research has provided one of the many possible answers to the question regarding why past investigations had obtained incoherent findings. Meanwhile, since this research is only a preliminary investigation of the relationships between styles and abilities when age and gender are taken into account, similar studies in the future are called upon. Moreover, future research may also consider the possible influence of other variables such as socioeconomic status and personality traits upon the relationships between intellectual styles and abilities.

Apart from its theoretical contribution, the present research also has its practical implications. It has long been established that abilities account for significant proportions of individual differences in academic performance (e.g., Burnham 1964; Jansen and Bruinsma 2005). Such a fact is well known among students and teachers. However, what is much less

well known among students and teachers is the substantial body of literature accumulated in the past two decades, indicating that styles also play an important role in academic performance (Grigorenko and Sternberg 1997; Messick 1996; Zhang 2004c). What is even less known is the fundamental independence of styles from abilities, in particular, when such variables as age and gender are taken into account. Therefore, results from the present research have implications for both students and teachers.

Students should be aware of the general finding that styles and abilities are largely independent because such awareness may, among other things, enhance students' self-esteem and increase their learning motivation. Very often, low academic achievers are inclined to consider themselves as having low abilities. By understanding that styles are just as important as abilities are in their learning and that styles are basically unrelated to abilities, low-achieving students may start developing more adaptive attributions to their "failures." They may, for example, start thinking that perhaps their low achievement does not mean that they have low abilities. Alternatively, they may start examining other factors that may have contributed to their low achievement. One such factor is their styles of learning. It is likely that they take a close look at whether or not their learning environments are suitable for their styles of learning. Consequently, instead of feeling badly about their own abilities, they may initiate ways of either adapting to or shaping their learning environments. Moreover, intellectual styles are changeable (Zhang and Sternberg, 2009). As such, students may purposefully work towards enhancing particular styles that are more conducive to positive learning outcomes.

The distinction of styles from abilities should also be encouraging to teachers because like among students, among many teachers, the number one suspect of poor academic achievement is also students' low abilities. A near-zero relationship between styles and abilities means that a student could, in theory, like to learn in a particular way, but not be good at it, or vice versa. With such an understanding, teachers may begin to examine the roles of intellectual styles in students' learning and in teachers' teaching in addition to paying attention to students' abilities. Furthermore, teachers should also take students' age and gender into account in their efforts to help students to work to the highest levels of their abilities and to capitalize on their intellectual styles.

Finally, the consistent finding that the practical scale in the STAT resulted in low internal reliability among Hong Kong Chinese students should draw the attention of researchers. Such a finding requires that researchers exercise cultural sensitivity in assessing practical abilities.

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Current themes of research:

Intellectual styles and creativity. Intellectual styles and student development. Intellectual styles and occupational stress (school teachers, academics, and business leaders). Intellectual styles and personality. Creativity. Giftedness.

(Intellectual style is used as an encompassing term such as cognitive, learning, teaching, and thinking styles)

Most relevant publications in the field of Psychology of Education:

Books:

Zhang, L. F., & Sternberg, R. J. (Eds.) (2009). *Perspectives on the nature of intellectual styles* (p. 310). New York: Springer Publishing Company.
Zhang, L. F., & Sternberg, R. J. (2006). *The nature of intellectual styles*. Mahwah, NJ: Lawrence Erlbaum Associates.

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