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Cognitive Styles and Fluid Intelligence: Are They Related?

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Abstract. This study was designed to find out whether there was any significant relationship between cognitive styles and fluid intelligence. To this end, the Group Embedded Figures Test (GEFT) and Standard Progressive Matrices (SPM) were administered to three hundred fifty five undergraduate and graduate university students as measures of cognitive styles and fluid intelligence, respectively. The students were first divided into two distinct groups, i.e., field dependent (FD) and field independent (FI), on the basis of their scores on the GEFT. The performance of these two groups on the SPM was then analyzed and compared with the GEFT. The T-Test analysis showed that the FI students' scores on the SPM were significantly higher than those of the FD. The findings are discussed and suggestions are made for future research.
Key words: Fluid intelligence, cognitive styles, field dependent, field independent

1. Introduction

As early as 7-9 months old human infants look for the objects observed being hidden by adults (Baird *et al*, 2002). The very act of looking for the hidden objects not only shows that the infants have created mental images or schemata of the objects hidden but also reveals their purposeful interaction with and exploration of their environments to reach their objective. In other words, the human infants possess general intelligence defined as "the aggregate or global capacity of the individual to act purposefully, to think rationally and to deal effectively with his environment" (Wechsler, 1944, p. 3, as cited in Fancher, 1985).

Horn and Cattell (1966) believed that general intelligence (G) is a composition of up to 100 different mental abilities which can be divided into two broad categories: fluid (Gf) and crystallized (Gc). While the former involves problem-

solving, flexibility of thought, abstract reasoning, and encoding of short-term memories (Cianciolo & Sternberg, 2004), the latter accrues as a result of education and cultural influences.

Similar to Horn and Cattell (1966), Hebb (1942) divided general intelligence into two categories, i.e., Intelligence A and intelligence B. The former has a biological basis whereas the latter results from the interaction of intelligence A with the environment (Hebb, 1942, as cited in Vernon, 1979). While intelligence A corresponds to Gf, intelligence B is not necessarily the same as Gc and there is, therefore, no specific test to measure intelligence B. Gc is, however, assessed by utilizing tests of general knowledge, vocabulary, or other acquired skills.

Tests measuring Gf are constructed with figures, diagrams, and drawings in order to "reduce the acculturational influences of Gc in measuring the reasoning" (Kaufman & Horn, 1996, p. 100). Advance Progressive Matrices (APM) and Standard Progressive Matrices (SPM) have been widely used in literature as two widely accepted measures of the Gf. Raven (1977) developed the latter based on Spearman's (1923) principle of neogenesis to "provide a test suitable for comparing people with respect to their immediate capacities for observation and clear thinking" (p. SPM2).

As two most relevant capacities, observing and thinking clearly play significant roles in achieving educational objectives in general and success at secondary and tertiary education in particular. Akbari and Aghayousefi (2010), for example administered the Raven's Progressive Matrices (intermediate forms) as a measure of Gf to 37 grade 2, 44 grade 3 and 31 preuinversity high school students aged between 16 and 19 (mean 17.6, SD = 1.12) and correlated it with the participants GPA as reported in their last year's report card. They found a significant correlation ($r = .52$, $p < .01$) showing that 27 percent of variance in participants' school achievement is explained by their fluid intelligence.

Along with school achievement, the relationship between Gf and a number of other variables have been explored. Di Fabio and Busoni (2007), for example, investigated whether Gf was related to personality traits while Di Fabio and

Palazzeschi (2009) extended it to emotional intelligence. Djapo et al. (2011) included crystallized intelligence in their research to find out how it bears on both personality and fluid intelligence.

Little attention, if any, has, however, been paid to investigate whether there is any significant relationship between fluid intelligence and other psychological traits measured non-verbally. The cognitive styles of field-dependence (FD) and field-independence (FI) are, for example, measured non-verbally by the Group Embedded Figures Test (GEFT) designed by Witkin *et al.* (1971). It measures the degree to which humans employ "an analytical as opposed to a global way of experiencing the environment" (Keefe, 1979, p.9). The present study is, therefore, designed to fill the gap and find out whether there is any significant relationship between fluid intelligence and cognitive styles of university students in Mashhad, Iran.

2. Methodology

2.1 Participants

Three hundred fifty five university students, 97 (27.3%) male and 258 (72.7%) female, took part in the study voluntarily. (Thirty one participants did not, however, complete all the tests for reasons beyond the researchers' control or did not answer most of the items on the tests. These participants were excluded from the study. (To be more specific, therefore, the number of participants who took the SPM and GEFT and answered all of their items is given in relevant tables.) Two hundred and eighty three (79.9%) and 72 (20.3%) were undergraduate and graduate students, respectively, majoring in agriculture (n = 55, 15.5%), English language and literature (n = 197, 55.5%) and psychology (n = 103, 29%) at Ferdowsi University of Mashhad. Their age ranged between 18 and 50 (mean = 23.15, SD = 5.12) and spoke Persian as their mother language. They had all registered in the courses offered by the first author and another colleague at the faculty of education and psychology in the two academic semesters offered in 2011.

2.4 Instruments

A bio data questionnaire, Standard Progressive Matrices, and Group Embedded Figures Test were administered for the present study.

2.4.1 Bio data questionnaire

Five short-answer questions dealing with the participants' age, field of study, academic degree, gender and mother language formed the bio data questionnaire.

2.4.2 Standard Progressive Matrices

The Standard Progressive Matrices (SPM) was designed by Raven, Court and Raven (1977) to measure whether test takers can see relations between meaningless figures. It contains 60 figures presented in five sets labeled A, B, C, D and E. Each set consists of 12 figures having a specific system of relations. A small part of each figure is cut off and presented along with six or seven choices which compete with the missing part in terms of the system of relations presented in the figure. Selecting the right choice thus requires developing a systematic method of reasoning.

Every attempt has been made to keep the first problem as self-evident as possible. However, as the test takers of all ages work through the SPM at their own speed without having any time limit, they find the problems raised in the figures progressively more difficult. According to Raven et al (1977)

> The order to the items provides the standard training in the method of working. The five sets provide the opportunities for grasping the method and give progressive assessments of a person's capacity for intellectual activity. To ensure sustained interest and freedom from fatigue, the figures in each problem are boldly presented, accurately drawn and, as far as possible, pleasing to look at (p. SPM2).

The reliability estimates reported for the SPM vary slightly due to the number of variables investigated by various scholars, e.g., the method used in reliability analysis and the age and number of participants. Sorokin (1954), for example, found a split-half reliability coefficient (RC) of 0.96 with Yugoslavian teenagers. In a more recent study, Abdel-Khalek and Raven (2005) reported

Cornbach's alpha RCs ranging between 0.88 (age 14) and 0.93 (age 9) by administering the SPM to a sample of 6529 Kuwaiti school students.

2.4.3 *Group Embedded Figures Test*

The Group Embedded Figure Test (GEFT) was designed by Witkin *et al.* (1971). It comprises eight simple forms numbered alphabetically from A to H. The test takers are required to find these simple forms hidden within 28 complex patterns presented in three sections. As shown in Figure 1, they have to find a simple form such as x on the left, in a complex pattern given in the middle and trace it in pencil in the complex pattern as shown on the right. The tracing must be in the same size, in the same proportions and in the same direction within the complex figure.

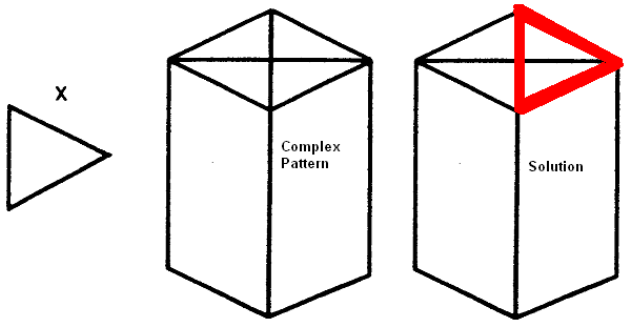

Figure 1

An example GEFT item requiring tracing figure x

While section one of the GEFT includes seven patterns mainly designed to warm up the test takers, sections two and three include nine patterns each. Each pattern is considered the dominant visual field and the test takers' ability to identify the labeled simple form within the pattern determines whether they are FD or FI. The first seven patterns are given for practice purposes. The highest score on the GEFT is, therefore, 18. The mean is taken to be 11 and the test takers whose scores fall below and above the mean are labeled FD and FI, respectively (e.g., Luk, 1998).

2.3 Procedures

Upon having all the tests copied and ready, the first author and his colleague announced in their classes that they needed a number of students who would sit for certain number of tests forming a part of their research project. (Some of them also took the Test of English as a Foreign Language. The findings based on their performance on this test and its relationship to Gf and cognitive styles will be presented in a separate paper.) It was also announced that whoever took the tests voluntarily, their participation will be considered as their class activity and they would receive an extra score of two out of 20 which will be added to their final scores. Whoever attended the testing sessions as scheduled and completed all the tests received the extra two as announced.

2.4 Data analysis

The descriptive statistics of the SPM and GEFT were calculated to determine how they functioned statistically. The reliability of both measures was estimated by employing the Cronbach's alpha. The T-Test analysis was employed to find out whether FD and FI test takers differed from each other significantly in terms of their mean scores on the SPM. All the statistical tests were run via IBM SPSS Statistics 19 to test the hypothesis that there will be no significant difference in the mean scores of the FD and FI test takers on the SPM.

3. Results

Table 1 presents the descriptive statistics of the SPM and the GEFT as well as their alpha RCs. As can be seen, the alpha obtained on the SPM is .80, which is according to Pallant (2007) "acceptable" (p. 292). Since the authors could not find any research projects in which the SPM had been administered as a measure of Gf in Iran, the result could not be compared with others within in an Iranian context.

Table 1

Descriptive statistics and reliability estimates of the SPM and GEFT

Tests	N	No of items	Mean	SD	Skewness	Kurtosis	Alpha
SPM	314	60	52.59	4.543	-1.464	3.503	.80
GEFT	286	18	8.30	4.231	.024	-.884	.84

Compared to the SPM, the GEFT enjoys a higher level of reliability, i.e., 0.84. This level of RC falls between the RCs obtained by Khodadady, Fatemi Hosseini and Etminan (2012), i.e., 0.87 and Khodadady and Zeynali (2012), i.e., .79. They administered the GEFT to 253 and 200 undergraduate and graduate students majoring in Teaching English as a Foreign Language, English Language and Literature, and English Translation, respectively.

Table 2 presents the descriptive statistics of 249 participants who took both the SPM and GEFT. As can be seen, while the majority are FD (N = 180, 72%), slightly more than one quarter of participants are FI (N = 69, 28%). As it can also be seen, the mean score of the FD participants (51.82) on the SPM is lower than that of FI (54.68). If the GEFT is accepted as a measure of cognitive styles, these results will then be alarming because the majority of students who will assume various educational positions in Mashhad, Iran, will be FD.

Table 2

Group Statistics of the SPM

Cognitive Style	N	Mean	Std. Deviation	Std. Error Mean
Field Dependent	180	51.82	4.342	.324
Field Independent	69	54.68	3.954	.476

Table 3 presents the T-Test analysis of the mean scores the FD and FI participants have obtained on the SPM. As can be seen, under both equal and unequal variance assumptions, the analysis shows that the FD participants' scores on the SPM is significantly lower than those of the FI. These results disconfirm the hypothesis that *there will be no significant difference in the mean scores of the FD and FI test takers on the SPM*.

Table 3

Independent Samples Test

	Levene's Test		**t-test for Equality of Means**						
	F	**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**	
								Lower	**Upper**
Equal variances assumed	1.546	.215	-4.773	247	.000	-2.864	.600	-4.047	-1.682
Equal variances not assumed			-4.977	134.49	.000	-2.864	.576	-4.003	-1.726

4. Discussions

Encountering incoming information FD individuals normally pay attention to its global aspects (Clark & Roof, 1988; Marendaz, 1985) and thus face difficulty in understanding its structure when it is presented orally (Bennink, 1982; Bennink & Spoelstra, 1979; Cochran and Davis, 1987; Robinson and Bennink, 1978). The tendency interferes with the performance of intellectual tasks requiring recognizing, analyzing and synthesizing the components constituting a whole (Goodenough & Karp, 1961; Witkin et al., 1962) and render these individuals passive and expectant

with regard to learning (Carter, 1988; Ennis, 1991; Goodenough, 1976). These distinct characteristics seem to have their roots in FD individuals' significantly lower fluid intelligence.

The findings of this study also seem to question those scholars who approach cognition as a two-dimensional construct (e.g., Bertini, 1986; Davis, 1991; Moallem, 2003, Saracho, 2003). Brown (2000), for example, stated that 'perhaps an "intelligent" and "successful" person is one who is "bicognitive" - one who can manipulate both ends of a style continuum' (p. 114). If fluid intelligence is approached as a construct measured by the SPM, then FI learners are significantly more intelligent than their FD counterparts. In other words, FD style is nothing but the lower degree of FI otherwise there would be no significant difference in the scores of the FI and FD learners on the SPM.

Not only are FI individuals superior to their FD counterparts in fluid intelligence but also they are more proficient in English as a foreign language (EFL) when it is measured by International English Language Testing System (IELTS). Khodadady and Zeynali (2012), for example, showed that "field-independent individuals are superior to field-dependent ones in the IELTS listening comprehension" (p. 629). Similarly, Khodadady, Fatemi and Etminan (2012) examined the relationship between cognitive styles and S-Tests, i.e., multiple choice item tests whose keyed responses have syntactic, semantic and discoursal relationship with the item alternatives and schemata comprising the reading texts. Their results showed that the FI test takers outperformed the FD not only on the S-Tests as a whole but also on their adjective, adverb, noun and verb subtests as well.

The findings of the present study are unique because the measures through which intelligence and cognitive styles were measured, i.e., the SPM and GEFT, were both non-verbal. Although the GEFT is much shorter than the SPM in length, it has the ability to differentiate more intelligent university students from the less intelligent. In other words, the GEFT is more of an intelligence measure than of a cognitive style. Future research must show whether the other established measures of cognitive styles, i.e., converger and diverger (Hudson, 1966), serialist and wholist

(Pask, 1976, 1988), active and reflective (Gregorc, 1982; Allinson & Hayes, 1966) as well as verbaliser and visualiser (Paivio, 1971, 1986), reveal similar patterns of relationship.

5. Conclusions

As a unique ability, Gf enables humans embark on abstract reasoning and solve their intellectual problems. These features make fluidly intelligent learners successful in their academic activities. The Gf seems to be very similar, if not the same as, FI cognitive style whose possessors are more achievement-oriented and competitive (Wooldridge & Haimes-Bartolf, 2006) than their FD counterparts. To compensate for their less Gf, FD students become "interpersonally oriented and rely heavily on external stimuli. This motivates them to look toward others for reinforcement of opinions and attitudes" (Wooldridge, 1995, p. 51) within educational settings.

Literature is largely mute as regards the hereditary nature of cognitive styles. If knowledge is considered as a psychological construct which is acquired through analytical analyses and abstract reasoning common to both fluid intelligence and FI, then it will be beyond FD individuals, at least at an academic level. While FI learners do have the ability to motivate themselves internally and thus do not need interpersonal intelligence, the FD learners establish and employ interpersonal relationships with their teachers and thus compensate for their lower intelligence and achievement.

In a recent study, Khodadady, Ghallasi-Fakhrabadi and Kanan-Azar (2013) extracted eight factors from a 102-item English Language Teachers' Attribute Scale (ELTAS) by administering it to 1328 female grade three high school students in Mashhad, Iran, i.e., i.e., *Qualified*, *Social*, *Stimulating*, *Organized*, *Proficient*, *Humanistic, Self-Confident*, and *Lenient*. Their results showed that the *Lenient* factor correlates the highest with *Humanistic* as a trait on the one hand and EFL achievement as a learned ability on the other, indicating that EFL teachers evaluate their learners' achievement more on humanistic grounds than on academic

standards. It remains to be explored whether a similar pattern appears if the achievement and proficiency level of FD university students are studied in terms of *Lenient* and *Humanistic* factors.

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