

Use of Fluid and Crystallized Intelligence Theory to Enhance Prediction of Learning Foreign Language Grammar

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Abstract

The aim of this study was to examine if there is any relationship between the two types of intelligences in Cattell's GF- GC theory and learning foreign language grammar among Iranian learners. To this end, 85 university students took part in this study. First, the participants were asked to take the Raven's Advanced Progressive Matrices (APM), then the researcher asked them to take part in Wechsler Adult Intelligence Scale (WAIS) separately, and the interview for each participant was recorded. The researcher used the students' grammar scores which were obtained from their professors as the measure of their level of grammatical knowledge. The result of the study showed that there are significant correlations between the two types of intelligences (fluid and crystallized intelligences) and foreign language grammar. Moreover, the result from path analysis showed that between the two intelligences in the GF-GC theory, fluid intelligence is a better cognitive predictor of learning foreign language grammar. Bearing the finding of this study in mind, language teachers should provide an environment in which students can develop their cognitive abilities such as abstract reasoning and critical thinking.

Keywords: Fluid intelligence, Crystallized intelligence, GF-GC theory

1. Introduction

People differ on many characteristics and are more different than they are alike. These characteristics are unique for every individual. Due to these differences, success of a second language acquisition varies greatly from person to person. Therefore, the awareness of the individual differences (IDs) can be influential for determining the most consistent predictors of second or foreign language success (Dornyei, 2005). IDs in psychology have been so closely associated with personality and intelligence (Birch & Hayward, 1994, Eysenk, 1994). The present study highlights the importance of recognizing intelligence as an ID factor in relation to foreign language grammar attainment.

Intelligence is generally defined as the ability to learn and overcome obstacles by taking thought (Dornyei, 2005). However, in the scientific sense, it is not a single construct and several theories have been proposed to describe this cognitive ability. In this regard, an early theory of cognitive ability that had particular influence on the psychometric tradition was Spearman's theory of intelligence. Spearman measured people performance on a variety of cognitive tasks and began to see that performance on one task positively correlated with performance on other tasks. He also noted that individuals did not equally perform well on all tasks, so he determined that along with general ability or "g", cognitive tasks had specific abilities or "s" which depends on practice and exposure. "g" appears to have a genetic basis but so far there has been little evidence for a genetic basis for "s" (Spearman, 1904). At about the same time, Cattell (1963) agreed with the psychometric approach to intelligence and took it further. He divided up general intelligence in to fluid intelligence (Gf) and crystallized intelligence (Gc).

2. Cattell's Gf-Gs Theory

According to Cattell (1963), *fluid intelligence* is what we refer to in abstract thinking and the use of deliberate mental operations to solve novel problems. Inductive and deductive reasoning are also considered as the hallmark indicators of fluid intelligence. Gf development depends on biological factors (Ridemann, Flores-Mendoza, & Mansur-Alues, 2010). But *crystallized intelligence* is mostly associated with the type of learning we have acquired from our past experiences, particularly, our cultural knowledge and skill. Therefore, unlike Gf, crystallized intelligence will continue to expand throughout our life time. In other words, GC might be more sensitive to effects of schooling than other cognitive abilities. Moreover, crystallized intelligence is, according to Cattle, the result of fluid intelligence and environmental stimulations through non-biological factors such as education, language-based declarative knowledge (knowing what) and procedural (knowing how) knowledge, leisure time and job complexity (Rindermann, Flores-Mendoza, & Mansur-Alues, 2010).

One of the academic domains for which this theory can be applied is learning foreign language grammar. Learning and teaching of grammar has become increasingly important among second or foreign language learners. The importance of learning grammar in a foreign language context should not be taken for granted, because it is one of the basic elements in second or foreign language learning. The teaching and learning of grammar itself is multidimensional and may require a variety of teaching approaches. For instance, some

believe that grammar learning takes place implicitly (Krashen&Terrel, 1983), in other words, they assert that grammar is best learned subconsciously when students are engaged in understanding the meaning of the language with which they were encountered. This is in congruent with form-focused instruction (Long, 1991). However, other scholars claim that explicit grammar teaching plays a more critical role in learning. Stated otherwise, they believe in forms-focused instruction and are of the view that declarative knowledge is more effective in learning grammar. It might be obvious that there is no clear idea in regard to learning and teaching grammar. As such, the role of Gf-Gc theory in learning grammar needs to be justified. That is, whether Gf (abstract reasoning) can be a predictor of the grammar learning or Gc (explicit and declarative knowledge) might be effective.

Although there are many researchers who agree on the positive relationship between cognitive ability and academic achievement in general (Chamorro-Premuzic & Furnham, 2005, Rinderman & Neubauer, 2001, Rohde & Thompson, 2007, Rothstein, Paunonen, Rush & king, 1994) and success in second language acquisition in particular (Fernandez-Corugedo, 1999, Genesee, 1976 & McLaughlin, 1987), very few studies have attempted to relate the two types of intelligences in Cattell's Gf-Gs theory to learning foreign language grammar among Iranian learners. Therefore, the present study intends to fill in this research gap.

3. Purpose of the Study

The main purpose of this study is to assess cognitive predictors of learning foreign language grammar. Therefore, it tends to investigate the relationships between two types of intelligences in the GF-GC theory (fluid and crystallized intelligence) and learning foreign language grammar. Taking into consideration the set objectives of this study, the following research questions were posed.

1. Is there any relationship between fluid intelligence and learning foreign language grammar?
2. Is there any relationship between crystallized intelligence and learning foreign language grammar?
3. Between the two types of intelligences in the GF-GC theory, which one is better predictor of foreign language grammar?

4. Method

4.1 Participants and Setting

The instruments employed in the present study were administrated to 85 senior undergraduate Iranian students majoring in English language and literature at Ferdowsi and Khayam universities of Mashhad, a north eastern city in Iran, in 2014. In order to ensure the homogeneity of the participants in terms of their general knowledge (for measuring crystallized intelligence), the researcher selected the third year university students. The participants' age ranged between 20 and 30. Available sampling was used in this study. What makes them common as far as their English educational background is concerned is that they share almost the same learning experience, i.e., a traditional English teaching method

practiced throughout the country at high school and university level.

4.2 Research Instruments

In the present study, two tests were employed: Raven's Advanced Progressive matrices (APM) have been utilized for measuring fluid intelligence (Gf), and Wechsler Adult Intelligence Scale (WAIS) for measuring crystallized intelligence (Gc).

4.2.1 Raven's Advanced Progressive Matrices (APM)

The Raven's Progressive Matrices have been used in many countries for decades as a measure of problem-solving and reasoning ability (Raven, Raven, & Court, 1998). In this study, for measuring fluid intelligence (abstract thinking and reasoning), APM was employed. APM is the advanced form of matrices contains 48 items, presented as one set of 12 (set I), and another of 36 (set II). However, in this study only set II (36 items) was conducted. Items are presented in black ink on a white background, and become increasingly difficult as progress is made through each set. These items are appropriate for adults and adolescents of above average intelligence. The time needed for this test is 45 minutes. APM has been standardized in Iran by Rahmani (2008) in Azad University of Khorasgan. The reliability and validity reported for the test are at acceptable level (.91 and .73 respectively).

4.2.2 Wechsler Adult Intelligence Scale

	N	Minimum	Maximum	Mean	Std. Deviation
Fluid	85	14.00	30.00	21.8471	4.13033
Cryst	85	114.00	165.00	139.891	12.07321
Struct	85	11.00	20.00	15.9900	1.94505
Valid N (listwise)	85				

For measuring crystallized intelligence (environmental and cultural knowledge), six verbal subsets of the WAIS were employed. WAIS was first released in 1955 by David Wechsler. The six verbal subsets of this scale were: Information, Comprehension, Arithmetic, digit span, similarities, and vocabulary. These tests show the participants' verbal IQ which is associated with their crystallized intelligence (Gc). WAIS was used for each individual separately by the trained examiners. The interviews were recorded for each participant.

4.2.3 The Participants' Structure Score

For measuring the state of learners' grammatical knowledge, the grammar scores which are obtained during their study at university (modern 1 and modern 2 course) were utilized.

4.3 Procedure

The participants took the Raven's Advanced Progressive Matrices (APM). The test lasted for 45 minutes. Then, the researcher asked the participants to take part in WAIS test for interview. Each participant took the test separately and the interview for each participant was recorded. Finally, the researcher obtained their grammar scores from their professors. All of these data were gathered for following analysis.

5. Data Analysis

Pearson correlation was used for finding the correlation. SPSS software (Statistical Package for Social Sciences) was used for descriptivestatistics. The descriptive statistics for the two types of intelligences and foreign language grammar are reported in Table 1.

Table 1. The descriptive statistics for the intelligence variables and foreign language structure

	N	Minimum	Maximum	Mean	Std. Deviation
Fluid	85	14.00	30.00	21.8471	4.13033
Cryst	85	114.00	165.00	139.891	12.07321
Struct	85	11.00	20.00	15.9900	1.94505
Valid N (listwise)	85				

The first and second research questions seek to find out if there is any relationship between fluid and crystallized intelligence and learning foreign language grammar. Pearson's Product Moment coefficient was utilized to assess the relationship between independent (Gf and Gc) and dependent (learners' grammar) variables. The results from Pearson correlation formula are shown in Table 2.

Table 2. The correlation between fluid and crystallized intelligence and foreign language grammar

Variables	Fluid intelligence	Crystallized intelligence	Structure
Fluid intelligence	1		
Crystallized intelligence	.26*	1	
Structure	.45**	.34**	1

Note: * $< .05$, ** $P < .01$

The result of Pearson correlation shows that there is a significant positive correlation between fluid intelligence and learning foreign language grammar (.45). Likewise, there is positive association between crystallized intelligence and learning foreign language grammar (.34). The third research question of this study sought to see which kind of intelligences in Gf-Gc theory is a better predictor of learning foreign language grammar. For this end, path analysis was conducted by using Amos (18 version). Generally, path analysis is used to describe direct and indirect casual relationships among variables. It is a special case of structure equation modeling, one in which only single indicators are employed for each of the variables in the

casual model. It is a powerful statistical mechanism which gives us a comprehensive analysis of the data. In the casual model below, the two exogenous variables (Gf and Gc) are modeled as being correlated and as having direct impact on endogenous variable (foreign language grammar).

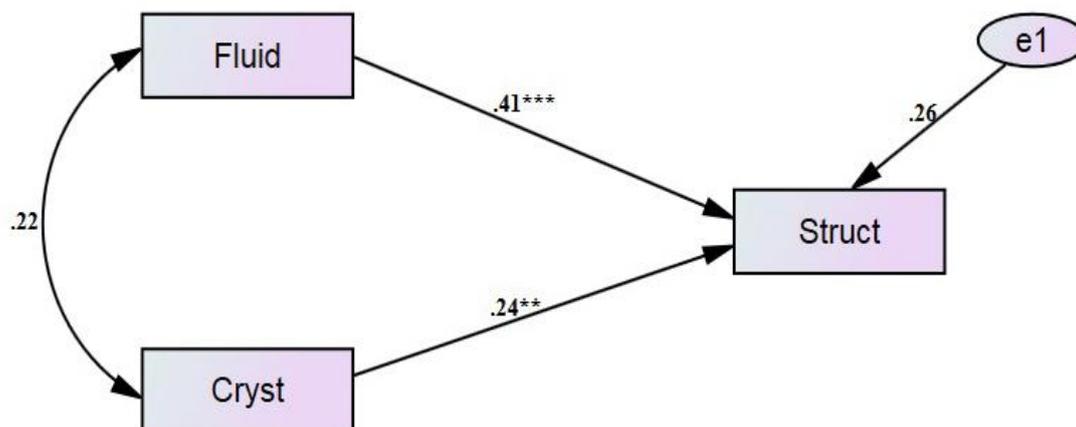


Figure 1. The path model of a casual structure for the GF-GC theory and learning foreign language grammar. **P<.01, ***P<.00

The initial path model was analyzed using the data from 85 participants. When the fit statistics were reported by Amos software, most of them were adequate. The fit indices for the path model are shown in Table 3.

Table 3. Goodness of fit

Fit index	x2/df	GFI	CFI	RMSEA
Acceptable range	< 3	>.95	>.91	<0.08
	.06	.91	.91	0.04

Research question three was answered by examining the paths between independent (fluid and crystallized intelligence) and dependent (foreign language grammar) variables. As it is clear in Figure 1, the two types of intelligences can predict learning foreign language grammar. There is positive influence of fluid intelligence on foreign language grammar (.41), and similarly, there is positive impact of crystallized intelligence on foreign language grammar (.24). However, among these two cognitive abilities, fluid intelligence can be a better predictor of learning foreign language grammar.

6. Discussion

This study sought to consider if there was any significant relationship between GF and GC and foreign language grammar. As far as the first and second research questions are concerned, the results from Pearson correlation formula have shown the positive relationships between these two types of intelligences in GF-GC theory and learning foreign language

grammar. In other words, both abstract thinking (inductive and deductive reasoning) and cultural knowledge and life experiences (declarative knowledge) play role in determining success in learning grammar. However, the results from the path analysis have reported that between these two intelligences, GF is a better predictor of grammar. That is, those who have higher cognitive abilities (abstract reasoning) are more successful in learning grammar when they encounter new problems. This view is similar to Piaget's (1952) view toward cognitive abilities. According to him, intelligence is intuitive in nature, therefore, students learn better when they construct their own understanding of language by thinking abstractly and formulating hypothesis and test them via applications. In this regard, the role of teacher is deemphasized. In order to create an environment which promotes abstract reasoning and discovery learning, L2 teachers can focus on implicit learning of grammar and utilize form-focused instruction in which learners' abstract reasoning can be used unconsciously. For instance, promoting students' noticing in understanding meaning of language, activates learners' mental processes in learning language. It might take the form of "input flooding, that is, increasing the number of times that students encounter the target structure in a particular text" (Schmitt, 2002, p. 30). Since language use is a skill, a meaningful practice is also needed. According to Larsen-freeman (2001), in regard to grammar, a practice is meaningful when students are asked to engage in a communicative task where it is necessary to use certain grammatical units meaningfully and appropriately to complete it.

7. Conclusion

The result from path analysis shows a positive significant path between GC and grammar, that is, general knowledge, particularly declarative knowledge, is a predictor of foreign language grammar. This result is similar to McLaughlin's (1987) theory of learning in which he suggests that language, like other skills, is acquired through intentional learning of 'declarative knowledge' and this declarative knowledge can become procedural knowledge through practice. Therefore, according to McLaughlin, the role of teacher is undeniable. This finding might be consistent with the view that L2 teachers can provide explicit teaching of grammar in order to boost their students' knowledge of rules. Moreover, based on the result of this study with respect to the impact of crystallized intelligence on grammar, textbooks and materials should focus on explicit learning of grammatical rules. However, it is important to mention that teachers need to use the resources with which they can promote real-life interaction when the need arises in form-focused instruction (Poole, 2003).

Although the present study shows that both fluid and crystallized intelligences can predict learning foreign language grammar, the findings illustrate that the fluid intelligence is a better predictor of foreign language grammar learning. Therefore, teachers should provide an environment in which they promote abstract reasoning and critical thinking in which they might activate students' mental processes. One technique which can increase creative and open-minded thinking among L2 learners is the teaching method of *debate*. Debating about different topic areas and different situations can increase critical thinking and also enhance communicative skills. Besides this technique, EFL teachers may use thinking-aloud technique to reveal how to think critically (for more information see, Wilhelm, 2001).

There were two general limitations to this study. One limitation was the gender variable was not taken into account in this study. Future studies need to pay closer attention to gender effect. The second limitation refers to the generalizability power of the findings of the study; since available sampling was used in this study, the findings have limited generalizability power.

Although the study answered three research questions regarding the role of fluid and crystallized intelligence in determining foreign language grammar attainment, there are still possible research topics for future exploration in this domain. For instance, as noted previously, because the participants were all Iranian EFL learners, there is no way of knowing whether the results concerning GF-GC theory and language grammar hold true for other EFL contexts or even ESL populations. Therefore, a logical future research topic is to implement the cognitive factors in relation to learning grammar in a different culture (such as China or Korea) and compare the results to those in this study. In addition, in further research, it would be interesting to examine whether the other cognitive factors such as personality and attitude have significant impact on foreign language grammar.

References

- Birch, A., & Hayward, S. (1994). *Individual differences*. Basingstoke: Macmillan.
- Cattell, R. B. (1963). Theory of fluid and crystallized Intelligence: A critical experiment. *Journal of Educational Psychology*, 54(2), 1-22. <http://dx.doi.org/10.1037/h0046743>
- Chamorro-Premuzic, T., & Furnham, A. (2005). *Personality and intellectual competence*. New Jersey: Lawrence Erlbaum Associates.
- Dornyei, Z. (2005). *The psychology of the language learner: Individual differences in second language acquisition*. London, NJ: Lawrence Erlbaum Associates.
- Eysenck, M.W. (1994). *Individual differences: Normal and abnormal*. Hove, England: Lawrence Erlbaum Associates.
- Fernandez-Corugedo, S. G. (Ed.). (1999). *Essays in English language teaching: A review of the communicative approach*. Spain: Servicio de Publicaciones.
- Genesee, F., (1976). The role of intelligence in second language learning. *Language Learning*, 26(2), 267-80. <http://dx.doi.org/10.1111/j.14671770.1976.tb00277.x>
- Krashen, S., Terrell, D. (1983). *The natural approach*. New York, NY: Pergamon.
- Larsen-Freeman, D. (2001a). *Teaching language: From grammar to grammaring*. Boston, MA: Heinle & Heinle.
- Long, M. (1991). Focus on form: A design feature in language teaching methodology. In K. De Bot, Ginsberg, R., Kramsch, C. (Eds.). *Foreign language research in cross cultural perspective*. Amsterdam: John Benjamins.
- McLaughlin, B. (1987). *Second-language acquisition in childhood: School-age children*. New Jersey: Routledge.

- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.
- Poole, A. (2003). New labels for old problems: Grammar in communicative language teaching. *Profile*, 4(1), 18-24.
- Rahmani J. (2008). The reliability and validity of Raven's progressive matrices test among the students of Azad Khorasgan University. *Knowl Res ApplPsychol*, 9(34), 61-74.
- Raven, J., Raven, J. C., & Court, J. H. (1998). *Raven manual: Section 4, advanced progressive matrices*. Oxford, UK: Oxford Psychologists Press Ltd.
- Rindermann, H., & Neubauer, A. C. (2001). The influence of personality on three aspects of cognitive performance: processing speed, intelligence and school performance. *Personality and Individual Differences*, 30(5), 829–842. [http://dx.doi.org/10.1016/S01918869\(00\)00076-3](http://dx.doi.org/10.1016/S01918869(00)00076-3)
- Rindermann, H., Flores-Mendoza, C. & Mansur-Alves, M. (2010). Reciprocal effects between fluid and crystallized intelligence and their dependence on parents' socioeconomic status and education. *Learning and Individual Differences*, 20(5), 544-548. <http://dx.doi.org/10.1016/j.lindif.2010.07.002>
- Rohde T.E., Thompson L.A. (2007). Predicting academic achievement with cognitive ability. *Intelligence*, 35, 83–92. <http://dx.doi.org/10.1016/j.intell.2006.05.004>
- Rothstein, M. G., Paunonen, S. V., Rush, J. C., & King, G. A. (1994). Personality and cognitive ability predictors of performance in graduate business school. *Journal of Educational Psychology*, 86, 516–530.
- Schmitt, N. (2002). *An introduction to applied linguistics*. New York: Oxford University Press.
- Spearman, C. (1904). General intelligence, objectively determined and measured. *American Journal of Psychology*, 15(1), 201-293. <http://dx.doi.org/10.2307/1412107>
- Wechsler D. (1955). *Manual for the Wechsler adult intelligence scale*. New York: The Psychological Corporation,
- Wilhelm, F. D. (2001). *Improving comprehension with think-aloud strategies*. New York: Scholastic.

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