The Effect of Reasoning Ability Enhancement on Academic Achievement of Iranian Foreign Language Learners

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Abstract

The ability to solve novel problems without retrieving information from memory and using logical reasoning is called fluid intelligence (Cattell, 1963). Fluid intelligence (Gf) is usually referred to as the ability to identify patterns and relationships with the help of reasoning. However, extensive studies (performed by Jaeggi et al., 2008; Vigneau & Bors, 2008) have shown that Gf can be improved and strengthened through training in its components of which inductive fluid reasoning is remarkable. In 1949, Cattell developed a test to measure cognitive abilities such as Gf . The underlying theories lagging behind the present research were the ideas of educability of Gf and the commonality shared by Cattell's test and English conjunctive adverbs. Since the implementation of Cattell's test and application of connectors involve different levels of fluidly inductive reasoning, the exposure to Cattell's test through application of connectors might improve the test scores of writing test. To this end, a total number of 60 junior students at participated in this study. The experimental group had 10 sessions of treatment in learning connectors and Cattell's test. The results showed the exposure to Cattell's test could increase the writing scores of English conjunctive adverbs. Finally, based on the findings of this study, a cognitively tentative perceptual framework was proposed.

Keywords: Fluid intelligence, Fluid reasoning, Cattell's test, English connectors, Cognitive model

INTRODUCTION

Writing authentic texts in English, taking international writing tests and posting English comments are among those activities that an L2 learner should be ready for. Thus, suggesting techniques and strategies for preparing L2 learners for their real life goals is of great significance. According to Cattell (1963), fluid intelligence (Gf) or fluid reasoning is the ability to reason fluidly. To measure Gf, Cattell (1949) developed the Culture Fair Intelligence Test (CFIT). It was an attempt to produce the measure of cognitive abilities that estimated the level of Gf or inductive reasoning apart from sociocultural influences. Fluid reasoning is the major type of reasoning that influences into other types of reasoning and abilities in a way or another. Although the primary definition of Gf implied the non- educability of Gf, later research studies showed slightly different results. Gf is

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trainable *(*Jaeggi et al., 2008; Vigneau & Bors, 2008). In fact, people can be trained to enhance their reasoning ability (G*f*) to better encounter different situations in their real life among which writing in L2 is of sophisticated importance in EFL settings where the medium language is not English. Rendering coherent texts, EFL learners are required to apply English conjunctives properly and according to literature using English connectors requires logic and reasoning (Marandi, 2002; Dafouz , 2008) .Therefore, to develop a coherent text, learners need to know how to apply connectors through strengthening their reasoning ability. This study used Cattell's test as an instrument to improve learners' reasoning ability.

G/Gf and connectors

Generally, Wilkinson (1989) states that writing as a language skill has positive correlation with students' general intelligence (G). He further continues that the ability to use function words including transitional words and expressions are linked with students' G. The findings of this study supported the idea that those who performed well on the Cattell's test, performed well on the conjunctive adverbs too. Besides, Falahati (2010) asserted that the test of transitional words and expressions could be one of the indicators of students' G. Worth to mention that G/G*f* are sometimes referred to interchangeably and each of them may represents the other one. Martinez (2000) believes that G*f* is a "close cousin" of G (p. 19).

Gf is trainable

Jaeggi et al., (2008) conducted a research study on dependence of G*f* on training. They assert that the amount of improvement in G*f* relies on the amount of training, the more training, the more improvement in G*f*. Also, Gray and Thompson (2004) contend that the lateral prefrontal cortex of the brain is responsible for G*f* when participants are being assessed and trained by the items from Cattell's (1949) Culture Fair Test .Therefore, inspired by the extensive previous research, this study tackled the improvement of G*f* by exposing the participants to Cattell's test. According Lohman and Lakin (2009), the previous knowledge is mostly activated on tasks which are based on reasoning with authentically stimulated materials. In a knowledge-based domain, the learner infers or deduce consequents in a problem-solving task (Lohman & Lakin, 2009).

Reasoning ability and English conjunctive adverbs

To write well, learners are required to restore cohesion and coherence to their written texts. Reasoning through writing necessitates appropriate application of conjunctives as a useful category of cohesive devices which help L2 writers to reflect their ideas coherently and effectively. The researcher in the present research, has chosen transitional connectors (conjunctive adverbs) because according to Marandi (2002), they engage learner's reasoning power while they are being used. She further asserts that conjunctive adverbs are based on writer's plausible reasoning power rather than mechanical devices. By the same token, Dafouz (2008) calls conjunctive adverbs as "logical markers" which indicate logical and reasonable semantic and structural relations

between pieces of discourse. Marandi (2002) also says that reasoning ability is crucially required to retrieve coherence to learners' writing. Thus, L2 writing instructors should note both strategy and language skill developments when working with the students to convey their written messages. Cohesive writing is easy to follow because it uses language effectively to guide the reader. It refers to how a writer creates and expresses the logical relationships between the parts of a text. The logical relationship between clauses, sentences, and paragraphs can be expressed by connectors (and, or, because, so) or they can be expressed by prepositional phrases (after that, in contrast) or adverbs (thus, alternatively) (Aronson, 2006). Here are some of the list of conjunctive adverbs practiced in this study:

- Also, besides, furthermore, additionally, so   (additional or consequential)
- Therefore, thus, consequently, so (consequential)
- Alternatively, similarly (comparative)
- However, nevertheless, otherwise, on the contrary (contrastive)

Gf, writing performance and academic achievement

In the present world, academic achievement is usually a pivotal target in education and learning. The academic achievement is a criterion for assessing and evaluating learning outcomes. It may also be considered as a criterion for behavioral changes of the learners at the end of exposure to the process of education and training. Moreover, academic achievement relies on different building blocks, such as schooling, social class of learners, G and personality (Chandra & Azimmudin, 2013).

According to Rohde & Thompson (2007) and Jensen (1998), academic success depends on G as the representation of a biological factor; therefore, it is advisable to focus on the extent to which the G influences the academic achievement, so that learners with different levels of G could optimize their academic achievements. Also, taking large scale tests such as IELTS and TOEFL for university admissions or migration purposes and also producing articles in English at tertiary levels in EFL settings need a good command of writing performance (i.e., coherent texts using conjunctives) and the desirable outcome would definitely be considered as an academic flourishing.

METHOD

Participants

A total of 92 female students at elementary level majoring in Psychology participated in this study. The participants' age ranged from 18 to 24. They all took PET (Preliminary English Test) and Cattell's Culture Fair test (1949) to see if they were homogenous in both their level of proficiency and level of Gƒ respectively. The extreme scores were excluded and the participants whose scores fell between one standard deviation below and above the mean were 63. They were randomly assigned into two groups, the control group (Gco) which consisted of 30 participants and the experimental group (Gex) which consisted of 33 participants. Three of the participants were excluded on their own decisions. Therefore, each group had the final number of 30 participants.

Instrumentation and Procedure

Both the Gco and Gex took a pretest in conjunctive adverbs. It was a 40 item test and the estimation of validity was obtained as 0.75. It has to be mentioned that Kuder-Richardson (KR-21) Formula was used to measure the reliability index of the current test.

The items had two types of recognition and production such as multiple choice items and cloze tasks. The test input was based on "Active Skills for Reading" (Book 1) by Anderson (2007) and "Select for Reading" (Elementary) by Lee & Gunderson (2002).

Both Gco and Gex went through the processes of writing instruction. They had instruction in conjunctive adverbs for 6 sessions twice a week. Each session lasted for 45 minutes. They were supposed to learn 4 connectors in each session. The approach to teach grammar was inductive. The researcher provided the participants with some examples of each targeted conjunctive adverb in contexts within full sentences using vocabularies that participants already knew, because the comprehensibility of input was important to the researcher so that the participants could understand the reasons for application of a specific conjunction. She introduced the conjunctive adverbs with only one form as:

- Independent clause; conjunctive adverb, Independent clause

It is noteworthy that the only step which was accomplished in Gco was teaching connectors. The list of connectors which was worked on during 6 treatment sessions was brought earlier in this article. Furthermore, the participants in Gex had exposure to Cattell's test.

Cattell's (1949) Culture Fair Test form A and B, was used as a Gf measurement which was based on reasoning ability or fluid reasoning. The test battery encompassed four problem subtests which had time restrictions. The total exposure time was 240. It was 4 sessions of 60- minute period. The participants were holding copies of questions in each session. The researcher explained the first three sample items and different types of reasoning using conjunctive adverbs. Participants took each test at the beginning of the session after listening to the researcher's instruction. Papers were corrected and each participant registered a score. The participants needed to know several reasoning types to arrive at the right answer some of which were inductive reasoning, linear and non-linear, and pragmatic reasoning. Besides, they were prompted to reason the items by turn or randomly assigned. The test items were discussed in order. The subjects listened to their peers' thinking aloud too. They reasoned about each item as the researcher supervised and consulted with them and corrected them if they reasoned with a wrong conjunction. Scores obtained from Cattell's exposure were only for tracking participants' level of daily improvement. The mere exposure to Cattell's test sufficed to follow its impact on learning connectors. An example of Cattell's item test is presented below.
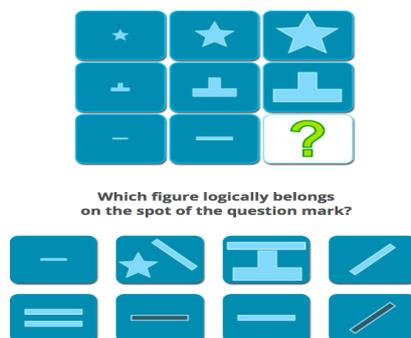
Figure 1. An example of an item of Cattell's Culture Fair Test. Answer is b.

As the item indicates, to arrive at the right answer, learners needed to infer the reasoning types or rules which was based on addition or subtraction of an element (e.g., middle line, the coloring or de- coloring) in distractors. The process of reasoning was performed by the researcher after the participants took the Cattell's test on each session. Then the participants were encouraged to reason using connectors similar to the researcher. Here is the way the researcher reasoned: The first shape is a small star; however, the second one is a bigger star. Moreover, the second row is follows the same pattern.

Consequently, in the third row the answer should be choice 7.Gex participants' daily performance is summarized in the following bar graph.
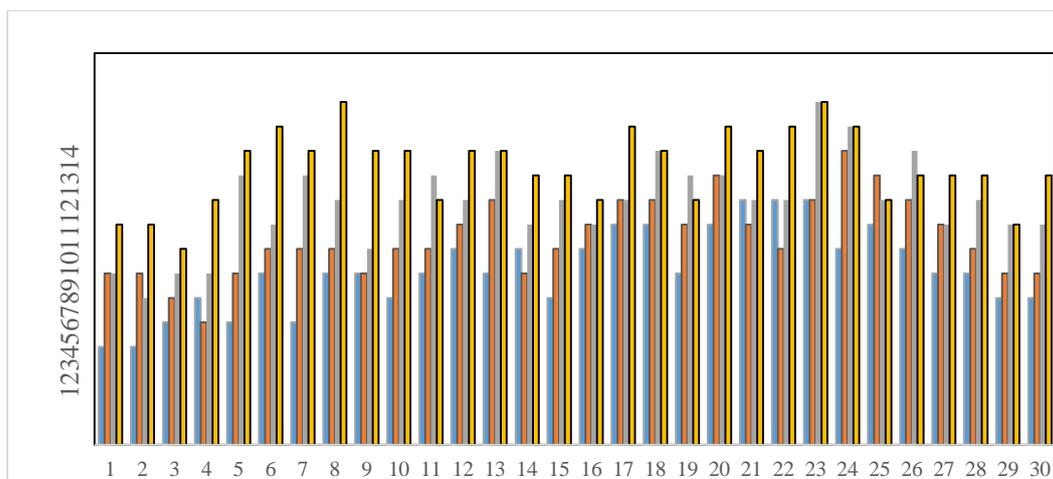

Figure 2. Delineation of daily exposure to Cattell's test

RESULTS

As the bar graph shows, on the first session of exposure, the lowest score was 1 and the highest score was 10. Also, the difference between scores was normal and was about two scores. The first test items were easier than the secondary ones; however, the dominance over fluid reasoning types may have not been sufficient to get better scores.

Besides, the lowest score obtained on the second session was 5 and the highest one was 12 out of 14. Although the secondary test items became harder, the highest score was 12. It can be inferred that the treatment and verbal instruction for burgeoning reasoning showed effectiveness. Besides, the difference between scores became less than the first

session and was registered as 1. This can be another indication of the effectiveness of the treatment. The lowest and highest scores on the third session of exposure was 6 and 14 respectively. It is noteworthy that the lowest and highest scores obtained on the second session were increased from 5 and 12 to 6 and 14. Moreover, the fluctuations of the scores on the fourth session substantiates the challenges needed to get correct answers while more complicated and multifaceted reasoning types needed to be provoked. According to Moray (1979), as the objective difficulty of a task is increased, it requires the allocation of more processing resources to maintain constant performance; thus fewer resources are available for later tasks. Furthermore, the bar graph indicated that the participants could improve their reasoning skill on the last session of exposure to Catell's test; nevertheless, several participants could not. Generally, in a comparison between the first and last session of exposure, all the participants could improve their reasoning performance, even in a small size which was 2 scores for participant 29.

To verify the impact of exposure to Cattell's Culture Fair Test on learning conjunctive adverbs, the researcher conducted an immediate posttest for Gex. The posttest was the parallel form of the pretest in conjunctive adverbs. To see if there was any statistically significant difference between the mean scores of pre and posttest, a paired samples t-test was conducted.

Table 1. Paired Sample T-Test Results

		Paired Differences						
					95% Confidence			
	Mean	Std.	Std. Error	Lower	Upper	t	df	Sig
Gex pre-post	-1.00	1.02	.00	-2.00	-1.00	-9.00	29	.00

A paired samples t-test was conducted to evaluate the impact of improving reasoning power Cattell's test on learning connectors. There was a statistically significant difference between the pretest (M=11, SD= 5.03) and posttest (M=13, SD= 400), t (29) = 9.00, $p <$ .05. The eta squared statistic (.07) indicated a moderate effect size.

DISCUSSION

Fortunately, the exposure to Cattell's test to burgeon learning connectors was promising as the results of immediate posttest indicated. Some reasons were of great significance to obtain this result. The exposure to inductive reasoning treatment was through discussion and group work. Besides, the participants listened to their peers' types of reasoning while the participants were trying to use relevant connectors. Therefore, they boosted their performance via sharing their skills and reviving their previous knowledge. According to Zahner and Moschkovich (2010), group work gives chances to learners to be involved in classroom discourse, to develop a shared understanding of their ideas, and increase the accountability of their choices. Also, the treatment was effective because learners had the capacity to prompt each other to evolve previous knowledge to new concepts. Besides, the researcher during group work invited the participants to consider new information and develop their reasoning skills. Group works are really effective in burgeoning reasoning skills because learners complete each other's reasoning types and

knowledge and evolve them by the help of teacher (Zahner & Moschkovich, 2010). In fact, Cattell's Culture Fair Test required the participants to reason fluidly. Moreover, the improvement of scores in posttest could be partially associated with cognitive transfer. Kundu et al., (2013) assert that many of the potentials through transfer last over the course of several months, proposing that the effects of the training are durable. In fact, the impact of transfer from Gf component (fluid reasoning) exposure was effective enough to have writing scores ameliorated. The improvement of the scores indicated that the processes of brain storming in fluid reasoning was successful enough through Cattell's test.

CONCLUSION AND PEDAGOGICAL IMPLICATIONS

The findings of this study substantiated how improving inductive reasoning ability affect academic achievement and how being trained in one of the components of Gf led to success in learning English connectors. Actually, the current research statistically proved that more fluidly intelligent learners can boost their outcome of their academic achievement which is leaning English connectors. This study may enjoy several implications as follows:

Reasoning skill improvement can become one of the implicit or explicit goals and objectives in material development. Other practical implications may pave the way for EFL students who have to submit their articles in English in their educational career. As a result, they need to improve their writing performance focusing on connectors. Also, connectors usage may be practiced in cell phone applications preparing the learners mentally ready to activate their inductive reasoning ability. To sum up, when a writer attempts to apply conjunctive adverbs, she activates reasoning ability which is a constructive element of writing performance and Gf. The following conceptual framework is proposed based on the results of the current study.

Figure 3. Conceptual framework in dependence of connectors on Cattell's test

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