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Success in Raven's Test as an Index of Intelligence: Does Bi/Multilingualism Matter?

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Abstract

The present study seeks to find out whether or not higher scores of bilingual and multilingual speakers in Raven's intelligence test owe a debt to their bi/multilingualism. To this end, 50 abridged versions of Raven's test were randomly distributed among a population of almost 200 freshman university students out of which forty four booklets were returned at the end of administration sessions. The results of statistical analyses proved that bilingual and multilingual speakers enjoy higher IQ levels. The significance test confirms the fact that cognitive development of individuals has a direct relation with the number of languages spoken by them.

Keywords: Raven's test, bilingualism, multilingualism, cognitive development.

Language is a mirror of mind. (Akmajian, et al. 2001, p. 9)

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1. Introduction

Psychologists use different methods to measure IQ, what is generally considered intelligence. The concept of IQ, or "Intelligence Quotient" was for the first time introduced by the French psychologist Alfred Binet in 1904. The term "quotient" refers to Binet's definition of IQ as Mental Age divided by Chronological Age which is often demonstrated as "M.A./C.A". This quotient is then multiplied by 100 to make it a whole number. An eight-year-old child, for example, with the mental ability of a 12 year old has a mental age which is 1.50 times his chronological age (12/8 = 1.5). When multiplied by 100, it gives the child's IQ: 150.

Originally developed by Dr. John C. Raven in 1936, the "Raven's Progressive Matrices (henceforth RPM) test is a standardized intelligence test that consists of visually presented geometric-analogy-like problems" (Kunda, McGreggor, and Goel, 2009, p. 1). In its abridged form, matrices of geometric figures are presented with one entry missing in each matrix, and the correct missing figure must be selected from a set of choices given following each matrix.

The RPM is a completely non-linguistic and non-mathematical test because the testees are not involved in letters or numbers. They are presented only with patterns of geometric shapes. This is why it can be used with speakers from any linguistic background and even numerous research works have shown that it is culturally neutral. "Adequate standardization, ease of use (without written or complex instructions), and minimal cost per person tested are the main reasons for its widespread international use in many countries around the world" (http: //www.tedaltenberg.com/cabrillo/cis132/final/ravens.php).

The Raven's test is supposed to tap the ability to extract and understand information from a complex situation, called deductive ability (Raven, Raven, and Court, 1998); however, the RPM test has demonstrated a high level of correlation with other multidomain intelligences, which have given it a position of centrality in the space of psychometric measures (Snow, Kyllonen, and Marshalek, 1984). It is no wonder, then, why it is often used as a test of general intelligence.

Scores from RPM can be used as an indication of a candidate's potential abilities for success in professional, managerial and high-level technical positions. Positions such as these require "clear thinking, problem identification, holistic situation assessment, and monitoring of tentative solutions for consistency with all available information" (http://www.pearsonassessments.com/HAIWEB/Cultures/en-us/Productdetail.htm?Pid=015-4686-76X). The impact of cultural or language bias is automatically eradicated because of the nonverbal aspect of each test.

1.1 Statement of the problem

Many SLA researchers have wondered whether or not knowing more than one language will result in enjoying higher intelligence and therefore be conductive to learning additional languages. Furthermore, it has been hypothesized that early bi/multilingualism helps the child analyze distinctive structural properties of alternative language systems (Klein,1995, in Bahrainy, 2007). There has been a huge amount of research into the impact of bi/multilingualism on intelligence over the few decades. From its onset, the related bulk of the research studies about bi/multilingualism and intelligence resulted in a lot of interest. The interestingly controversial characteristic of these studies was that they were filled with mixed and contradictory results and findings. This

was due to the fact that some of these studies magnified the advantages and some focused on the disadvantageous effects of bilingualism and multilingualism on intelligence.

The objective of the present study is to find evidencefor the hypothesis that there is positive relation between individuals' intelligence quotients and the number of languages they speak.

1.2 Bi/Multilingualism and intelligence

"Bilingualism is to intelligence as food is to human fitness. The relationship between the two is both central and controversial."(Baker, 1988, p. 1).

The relationship between intelligence and bilingualism might be important and simple for parents or teachers. The relation may give rise to such questions as whether, in learning or speaking two languages, the child will become less intelligent, more intelligent, or that bilingualism will leave no effect whatsoever. If someone is going to justify bilingual education, they should build the justification partly on the "resolution of the intelligence issue" (Baker, 1988, p. 1). Bilingual education becomes justifiable when a child benefits cognitively from being bilingual. Support for such an education system may, on the other hand, be more difficult to find when there are deficits in being bilingual.

Stating a simple proclamation about bilingualism and its relation with intelligence is almost impossible. It is similar to prescribing one simple food for human survival. It is like being naive and simplistic to declare that bilingualism has positively beneficial or negatively detrimental effects on intelligence. In order to be clear and decided in what the relationship between the two might be,three fundamental problems must first be solved: the first concerns the definition of bilingualism, the

second involves its measurement and the third pertains to intelligence itself.

1.2.1 definition of bilingualism

Being bilingual is ambiguous. Who do we call a bilingual person? The initial issue is related to dimensions. Is that really necessary to show literacy as well as oracy in two languages in order to be called bilingual? Mackey (1962) suggests the four basic language skills of listening, reading, speaking and writing. Of course, it should be remembered that these four skills can be further subdivided. For example, in speaking two languages, there are differing degrees of variation among people in terms of the amount of vocabulary, accuracy in grammar and correct pronunciation.

Take as an example university students from Tehran who study in Mazandaran. They may be able to understand spoken Mazandarani but speak it awkwardly. Are these students bilingual? If the context or domain of language usage is added to the many dimensions of language skill, defining who is or is not bilingual becomes even more difficult. While someone may be quite competent in both languages, one of them may be restricted to be used only at home. Or it may be the case that each language is used in a narrow or broad range of contexts. The context or domain of language usage defines when each language is spoken, to whom, where and why (Fishman, 1965). Taking into account the vast number of dimensions of skill in each language and the great range of different contexts where a language may or may not be used, it becomes quite obvious that it is almost impossible to simply categorize who is or who is not bilingual.

1.2.2 Measurement of bilingualism

When assigning someone as monolingual or bilingual is so difficult, how do the researchers obtain their samples and gather their data? The key question is that of generalization. "If the sample is biased towards certain types of bilinguals (e.g. those with great skill on many dimensions who are bilingual in many varying contexts), then the results may have very limited validity and applicability."(Baker, 1988, p. 3).

Controversy partially lies in the use of balanced bilinguals in research. Balanced bilinguals are sometimes thought of as being representative of bilinguals. Although balanced bilinguals may be claimed to possess approximately equal skills in both languages, this does not necessarily imply that the language skills of these speakers are at a high level or that they are highly competent bilinguals. Baker (1988) believes that

> … in terms of the reception and production of oral and literary language skills, a person has almost equal competence. While in theory, the less gifted and the more gifted bilinguals may be included as "balanced bilinguals", MacNab (1979) has suggested that, in practice, restricting the choice of bilinguals to balanced bilinguals in research has led to the selection of a special and non-representative group. Cummins (1976) has disputed this, believing that use of balanced bilinguals induces only the slightest of biases in the research. (p. 3)

1.2.3 Intelligence

The most severe restriction and criticism of the bilingualism and

intelligence research can be found in the problems of defining and measuring intelligence and in using IQ tests.

Pyle's (1979) answer to the question of "what is intelligence" is a straightforward "… that we are just not sure!" (p. 1). He also believes that intelligence is "situation-specific". By this he means that the word is used in different situations where it adopts different meanings.

According to Coppin (2004), this question is a really complex one "with no well-defined answer that has puzzled biologists, psychologists, and philosophers for centuries." (p. 4). Intelligence can be defined by the properties it exhibits: "an ability to deal with new situations; the ability to solve problems, to answer questions, to devise plans, and so on. It is perhaps harder to define the difference between the intelligence exhibited by humans and that exhibited by dolphins or apes."(Coppin, 2004, p. 4).

Intelligence has been applied to human behavior in different ways. A feature that many definitions of the term have in common is "the notion of a purposeful adaptive behavioral response to the demands of the environment" (Butler and Hodos, 2005, p. 108). It is not yet clear whether intelligence is a general characteristic of an organism applicable to many diverse situations, a combination of a number of rather specific abilities, or a mixture of both. A very important issue necessary to be taken into consideration in applying intelligence to other animals is that "it is not a biological property of organisms, such as height, cranial volume, or cortical surface area. It is a value judgment on the part of the observer about the merits of the behavior observed."(Butler and Hodos, 2005, p. 108). It is the intelligence tester who decides which behaviors are of importance to measure. If the subject, whether a human or an animal, is able to perform those behaviors well, the tester reaches the

conclusion that "the subject is very intelligent. Poor performance on the test results in a rating of low intelligence. In a different culture, however, a very different set of behaviors might be rated as 'intelligent'"(Butler and Hodos, 2005, p. 108).

To bring this discussion to close, it should be added that "historically, there are many different definitions of intelligence (Sternberg, 2000b; Sternberg and Detterman, 1986, in Sternberg, Jarvin, and Grigorenko 2011, p. 146). The majority of the definitions of intelligence have tended to emphasize two important skills: "adaptation to the environment and the ability to think and learn. In more recent times, a third component has been added to the definition, namely, understanding of oneself and one's own skills, often referred to as metacognition. Broadly speaking, metacognition also includes theory of mind, in general, or one's understanding of how other people's minds work as well."(Sternberg, Jarvin, and Grigorenko 2011, p. 146).

One more point is that intelligence may be comprehended differently in different cultures (see reviews in Berry, 1991; Nisbett, 2003, 2009; Serpell, 2000; and Sternberg and Kaufman, 1998). The differences are important because of the fact that evaluation of members of cultures and that of outsider members is done in terms of their own conceptions of intelligence.

2. Review of the Related Literature

It was in the early 1920s that psychological studies of the relation between bi/multilingualism and cognitive abilities began because of the concern raised by the flourishing of psychometric tests of intelligence. The main concern was that "bilingual children would suffer from some linguistic disadvantages, which could, in turn, prevent fair assessment of their intellectual abilities and potential." (Hakuta and Diaz, 1985, p. 320. For a

more complete review of negative side-effects of bi/multilingualism see articles and reviews by Peal and Lambert, 1962; Carrow, 1957; Harris, 1948; Saer, 1924; Barke and Williams, 1938; Grabo, 1931; Arsenian, 1937; Darcy, 1953, 1963; Macnamara, 1966; Anastasi and Cordova, 1953; Jespersen, 1922; Mattes and Omark,1984; Printer and Keller, 1922; Saer, 1923). All these studies indicated "that bilingual children suffered from academic retardation, had a lower IQ and were socially maladjusted as compared with monolingual children." (Keshavarz and Astaneh, 2004, p. 296).

Most early studies in the area severely suffered from a wide variety of methodological problems, and consequently, most of the investigators today regard the findings of early studies to be totally unreliable (see Cummins, 1976). "A good number of early studies, for example, failed to control for group differences in socioeconomic status between bilingual and monolingual samples…. A second major methodological flaw of early studies is that it was often questionable whether the 'bilingual' subjects were in fact fluent in both languages."(Cummins 1976, p. 321).

A large part of the findings reported above indicates a severe lack of consensus among the researchers regarding the advantages and/or disadvantages of bi/multilingualism. Some earlier research (Jespersen, 1922; Saer, 1923) and some of more recent ones (Darcy, 1953; Mattes and Omark,1984) suggest that bilingualism is associated with negative consequences. These studies were indicative of lower IQ, severe academic retardation and social instabilities in the case of bilingual speakers. Printer and Keller (1922) reported a *linguistic handicap* in bilingual children and Jespersen (1922) was convicted that bilingualism had a negative effect on intelligence. He contended that bilingual children could hardly manage to learn either of the two languages perfectly.

This could also slow down learning other things because the bilingual children's minds were busy learning the two languages simultaneously. Saer (1923) mentioned *mental confusion* to describe the bilingual speakers' cognitive functioning. Mattes and Omark (1984) claimed that bilingual children are more prone to stuttering.

Exactly contrary to the above-mentioned findings, some researchers compared monolinguals and bi/multilinguals and showed that the latter group could establish the relationship between words and their referents with relatively more comfort.

On the basis of several studies, it was hypothesized that bilingual children have an advantage over monolinguals in their control of the linguistic processing needed for metalinguistic problems in particular (Bialystock, 1986; Bialystock and Ryan, 1985).

Eisenstein (1980) found that childhood bilingualism had a positive effect on adult aptitude for learning a foreign language. According to him, the benefits of limited bilingualism are especially likely to emerge when the students have received formal instruction in their second language (Eisenstein, 1980). Thomas (1988) compared the acquisition of college French by English monolinguals and English/Spanish bilinguals. Her study yielded striking differences between the two groups, with the bilinguals outperforming the monolinguals. Thomas (1988, p. 240) reached the conclusion that bilinguals involved in "learning a third language seem to have developed a sensitivity to language as a system which helps them perform better on those activities usually associated with formal language learning than monolinguals learning a foreign language for the first time." (citedin Bahrainy, 2007, p. 7).

A review of the literature on bilingualism provides considerable positive evidence that bilingual speakers develop some skills not emerging

merely from biliteracy. (For details see McLaughlin and Nayak, 1989; Baker and Jones, 1998; Cenoz and Valencia, 1994; Lambert, 2000;Ianco-Worrall, 1972; Ben Zeev,1977, Modirkhamene, 2006, p. 285).

On the other hand, the results of some other studies led to a neutral attitude toward bilingualism. For example, Barik and Swain (1976) carried out experiments on larger samples who had been controlled for sex and age. They found no significant difference between monolinguals and bilinguals in terms of their intelligence, mental developments and school achievements. Nayak*et al*. (1990) compared monolingual, bilingual and multilingual speakers acquiring an artificial grammar. They reported that the multilingual speakers in their study showed far better performance under certain circumstances; however, there were no obvious evidence indicating that they were superior in language learning abilities to mono- and bilinguals. Diaz (1985) criticized the researchers comparing bilingual and monolingual subjects and contended that many variables, other than the number of languages spoken by the subjects, made it difficult to draw straightforward conclusions. As a result, instead of searching for general effects of bilingualism on cognition, researchers set out to address the particular circumstances under which bilingualism affected cognition (Nanez*et al*., 1992). Such factors as social acceptance of the languages, proficiency level in both (all) languages, socioeconomic status, and language acquisition patterns were identified as variables that affected cognition. The cognitive advantages of bi/multilingualism have not been reported in all research work being carried out so far. Some researchers, for instance, believe that bilingualism has no outstanding positive or negative effect on the development of cognition (for more details see Romaine, 1995; Klein, 1993a,1995;Thomas, 1988, 1992;Zobl, 1992;Bahrainy 2007; Magiste, 1984; Balke-Aurell and Lindbald, 1982;

Van Gelderen*et al.* 2003).

3. Method

3.1 Subjects

In order to provide evidence for the fact that bi/multilingualism positively affects the individuals' IQ and to discard negative or neutral views negotiated above, a sample comprising 50 students was chosen through simple random sampling method without replacement. A descriptive summary of the subjects follows in Table 1.

3.2 Instruments

Abridged versions of Raven's test were distributed among thechosen subjectswho were freshman university students. Finally, 44 booklets were returned at the end of administration sessions. The subjects belonged to both genders, different economic and language backgrounds and majored in different subjects. A further process of interview was carried out to make sure that the subjects were bi/multilinguals in the true sense of the term.

3.3 Data analysis

To analyze the collected data, SPSS version 15 was utilized. One-Way ANOVA, Independent-Sample *t*-test and Bivariate Correlation were especially used to run the necessary statistical operations.

3.4 Research variables

Age, gender, economic status and number of languages spoken by the subjects were taken as independent variables and the scores obtained from the RPM test as an index of the subjects' IQ level were taken as dependent variable.

3.5 Research hypothesis

The IQ level of bi/multilingual speakers is higher than that of monolingual speakers.

Table 1. Case summaries

	age	gender	languages	major	Economicstatus	Ravenraw	RavenIQ
1	19.00	male	multilingual	accounting	medium	35.00	127.00
2	19.00	male	bilingual	accounting	medium	34.00	124.00
3	19.00	male	bilingual	physics	medium	35.00	127.00
4	27.00	male	monolingual	physical training	good	32.00	119.50
5	20.00	female	bilingual	laboratory sciences	good	36.00	130.00
6	20.00	male	bilingual	psychology	medium	33.00	121.00
7	20.00	female	monolingual	accounting	good	33.00	121.00
8	20.00	male	bilingual	accounting	medium	36.00	130.00
9	19.00	male	bilingual	accounting	good	36.00	130.00
10	21.00	female	monolingual	law	good	30.00	115.00
11	23.00	female	monolingual	accounting	medium	35.00	127.00
12	23.00	male	bilingual	accounting	medium	36.00	130.00
13	19.00	male	bilingual	building	medium	34.00	124.00
14	18.00	female	bilingual	law	good	36.00	130.00
15	21.00	male	bilingual	accounting	medium	36.00	130.00
16	33.00	male	bilingual	management	good	36.00	130.00
17	19.00	male	bilingual	law	good	35.00	127.00
18	19.00	male	monolingual	accounting	medium	34.00	124.00
19	21.00	female	bilingual	forestry	good	35.00	127.00
20	25.00	male	monolingual	psychology	medium	36.00	130.00
21	20.00	female	bilingual	law	good	36.00	130.00
22	20.00	female	bilingual	management	good	34.00	124.00
23	20.00	male	bilingual	accounting	medium	36.00	130.00
24	25.00	female	monolingual	physical training	medium	30.00	115.00
25	28.00	female	bilingual	physical training	medium	34.00	124.00
26	27.00	female	monolingual	physical training	medium	31.00	116.50
27	32.00	female	bilingual	physical training	medium	36.00	130.00
28	29.00	male	multilingual	architecture	medium	36.00	130.00
29	32.00	female	monolingual	physical training	weak	15.00	82.00
30	58.00	female	bilingual	law	good	36.00	130.00
31	19.00	female	bilingual	accounting	medium	36.00	130.00
32	19.00	female	monolingual	accounting	good	27.00	121.00
33	21.00	female	monolingual	physical training	medium	36.00	109.00
34	20.00	female	bilingual	laboratory sciences	medium	33.00	130.00
35	21.00	female	bilingual	architecture	good	36.00	130.00
36	19.00	female	monolingual	management	medium	32.00	130.00
37	19.00	female	bilingual	green space	good	36.00	130.00
38	19.00	male	bilingual	civil engineering	good	36.00	130.00
39	19.00	female	bilingual	accounting	good	35.00	127.00
40	25.00	male	bilingual	construction	medium	35.00	127.00
41	24.00	male	bilingual	physical training	good	34.00	124.00
42	21.00	female	bilingual	laboratory sciences	medium	34.00	124.00
43	22.00	female	bilingual	management	good	36.00	130.00
44	41.00	male	monolingual	political sciences	good	34.00	124.00
Total	44	44	44	44	44	44	44

Participants had almost 50 minutes to complete the test. After completion, the booklets were scored according to the number of correct answers. Using the standardized table, the raw scores were then converted into IQ scores.

The objective of the study was to find out whether a relationship existed between the number of languages the participants spoke and their IQ scores, that is, whether bilinguals and multilinguals necessarily enjoyed higher IQ scores than monolinguals or not.

The raw and converted scores of the participants can be found in Table 1 above.

4. Results and Findings

To find out any relationship between the Raven's IQ scores as dependent variable and other independent variables (age, gender, bi/multilingualism and economic status) different statistical tests were run, the results of which follow:

1. The results of the analysis indicated no statistically significant relations between age and IQ level of the participants.
2. No such relation was observed between IQ level and gender.
3. The relation between economic status and IQ level was also calculated. The results indicated that such a relation was missing although it is controversial. The controversy originates from the fact that the economic status can be an influential factor on IQ because of the fact that the nutrition situation of the testees, which is a function of economic status, can leave great hormonal effects which itself affects the mental function of the participants (for example, see Suvarna and Itagi, 2009).
4. The comparison between IQ as dependent variable and the number of languages the participants used to know (monolingual, bilingual, and multilingual) as independent variable demonstrated statistically significant

relations. The results are offered below:

Table 2: Comparison between the number of languages and the IQ scores

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
monolingual		13	118.0000	12.44488	3.45159	110.4796	125.5204	82.00	130.00	
bilingual		29	127.9310	2.78941	.51798	126.8700	128.9921	121.00	130.00	
multilingual		2	128.5000	2.12132	1.50000	109.4407	147.5593	127.00	130.00	
Total		44	125.0227	8.34082	1.25743	122.4869	127.5586	82.00	130.00	
Model	Fixed Effects			7.12410	1.07400	122.8537	127.1917			
	Random Effects				4.62355	105.1292	144.9163			38.61261

Table 2 demonstrates the descriptive statistics resulting from the comparison between the number of languages participants spoke and their Raven's IQ scores.

Table 3. Test of homogeneity of variances

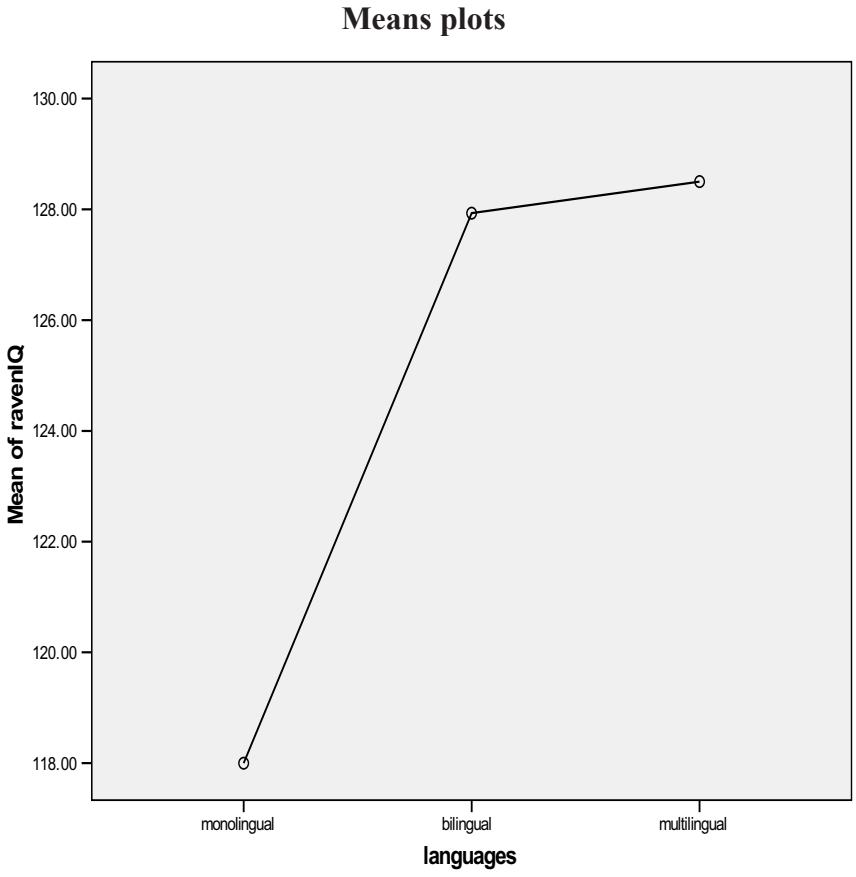
Levene Statistic	df1	df2	Sig.
5.821	2	41	.006

Table 3 shows that the equality of variance for the three populations (monolinguals, bilinguals and multilinguals) is rejected because of the statistic of 5.821 and significance level which is smaller than 0.05% (p=0.006).

Table 4. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	910.615	2	455.308	8.971	.001
Within Groups	2080.862	41	50.753		
Total	2991.477	43			

Table 4 reports the results of the ANOVA. Regarding the Fisher statistic (8.971) and the level of significance smaller than 0.05% (p=0.001), it is concluded that a strongly significant relationship exists between the participants' IQ level and the number of languages they speak. In other words, it is proved that bilingual and multilingual speakers enjoy higher IQ levels. The significance test confirms the fact that cognitive development has a direct relation with the number of languages spoken by the speakers. Therefore, the hypothesis of the present study is confirmed.



The means plot was also calculated for the three groups of participants. This plot demonstrates that there is a great distance between the mean of monolingual speakers on the one hand, and the mean of bilingual and multilingual speakers on the other, which further demonstrates the .statistically significant relation shown in Table 4

5. Discussion

Research during the past few decades has relatively consistently shown that learning one or more additional languages in childhood, whether through simultaneous acquisition or through bilingual education, is closely related to a higher IQ level and positive cognitive achievements. In both monolingual-bilingual comparisons and in studies using "within-bilingual" designs, children's bilingualism is positively related to concept formation, classification, creativity, analogical reasoning, and visual-spatial skills, to name a few, all of which require higher IQ levels (see Diaz, 1983; Hakuta, Ferdman, and Diaz, 1987, cited in Bialystok, 1991, p. 167). The findings of this study confirm the existence of relation between bi/multilingualism and higher intelligence.

There are several explanations for this positive relation (for a review see Diaz, 1985a). However, one of the widely-known explanations belongs to Peal and Lambert (1962) who attribute higher intelligence scores of bi/multilingual speakers to greater mental flexibility and a greater facility in concept formation that monolingual children donot enjoy. They further believe that this can also be attributed to the bilinguals' ability in manipulation of two or more symbolic systems and simultaneous analysis of the underlying semantic features in greater details.

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