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Comparing Cognitive Abilities of Monolinguals and Bilinguals: An Evaluation of Reliability Measures

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ABSTRACT

Man spends a major part of his time in the preparation, production and interpretation of linguistic utterances of diverse kinds. The process of learning a language is not only to learn the linguistic forms of the language but also to use them appropriately in several contexts. Proficiency in a language does not only mean that one knows what has to be marked and expressed but also to understand as to what shall be inferred by the listeners. Language and cognition are intimately related disciplines but the exact dynamics of this relationship has been the subject matter for several debates and controversies. There is another common sense perspective which runs across several disciplines. Many linguistics and anthropologists believe that the language learnt by an individual greatly affects his way of thinking and communicative abilities. In the present study, cognitive abilities of monolinguals and bilinguals were compared. This approach to unravelling the language-cognition relation is the main issue in the school of cognitive linguistics which also gave rise to a question whether monolinguals or bilinguals are more proficient in their abilities to assess different cognitive structures A clear cut answer regarding the role of lingualism in the development of cognitive abilities is not available in the mentioned literature. Different studies clearly indicate conflicting results. Some of the studies have shown that bilinguals outperform monolinguals in all the above listed cognitive abilities whereas other studies indicate that monolinguals perform better than bilinguals in certain cognitive abilities. Therefore bilingualism has been the relevant topic for years. . Keeping in mind the available literature cognitive abilities viz., intelligence, problem solving ability, concept formation and creativity were taken into consideration and were analysed using a t-test. Along with this the reliability coefficients of all the variables and the measures used in the study were estimated using Split-half, Test-retest and inter-scorer method.

Keywords: Cognitive abilities, Monolinguals, Bilinguals.

INTRODUCTION

Language is considered as a cognitive tool because acquisition of a natural language lends to the child an alternative representational medium for thought. The approach towards unravelling the language-cognition relation is the main issue of the school of cognitive linguistics (Geeraerts and Cyckens, 2007). Furthermore, right from the beginning, it has been realized that language itself plays a considerable role in giving a concrete shape to human thinking. During the past century, this view has gained strength. The factors that have contributed to develop this realization include a linguistic analysis of radically different languages (Sapir, 1956). The linguistic turn‟ in philosophy in the mid-20th century (Rorty,

1992) and the application of socio-cultural approach in psychology (Vygotsky, 1978). After a period of disagreements and disputes, the work of Whorf (1956) has once again gained influence, and various interpretations of his thesis "linguistic relativity" have being discussed and debated. They have been put to empirical scrutiny much more rigorously than ever before. Language and cognition are intimately related disciplines but the exact dynamics of this relationship has been the subject matter for several debates and controversies. Slobin (1987) made it clear through research on narrative production across languages that people come to self realisation of a special kind when they enter into the process of 'thinking for speaking' in which cognition plays a dynamic role within the framework of linguistic expression. Following the tradition of Aristotle, many philosophers, and more recently psychologists and linguistics have given place of privilege to cognition, in an effort to explain language as a faculty determined by the nature of the human mind. According to Gallagher (2005), 'language has phenomenological and empirical interpretations i.e. language should be considerably determined by human corporal existence'. Utterances seldom give a direct reflection of the 'objective' or 'perceived' reality i.e. we hardly have a universal mental representation of the situations around us because each one of them can be described in several ways. This is true both within and across languages. Each one of the natural languages of the world provides a closed set of options for the grammatical encoding of the ways and means to describe various characteristics of objects and events.

Studies on bilingualism and its relation with cognitive development were triggered by the educators who felt the need to address the social concerns of United States at the dawn of the 20th century. The large number of immigrants who came to America, especially from parts of eastern and southern Europe were poorly adapted to American society. Even empirical data from intelligence tests on the immigrants also pointed this fact. Explanations for low levels of performance came from psychologists belonging to two different schools of thought. One group called hereditarians with Lewis Terman (1919, 1975) and Goodenoough (1934) in the lead advanced the argument that intelligence is hereditary and innate and the poor performance of immigrants had an explanation in the intellectually and genetically inferior stock from where they came. Psychologists and educators holding this view did not consider bilingualism of the immigrants as a factor for poor performance. On the other hand, environmentalists like Stoddard and Wellman (1934) argued that bilingualism of the immigrants was responsible for their poor performance and that in general knowledge of two languages negatively effects the cognitive development as it leads to mental confusion. Jespersen (1922) also opined that a child can hardly learn two languages perfectly in comparison to one because the mental effort required to master two languages diminish the power of learning of other things. Thus bilingualism was considered an obstacle for both cognitive and linguistic development. In contrast to these findings, linguistics during the same period continued to provide accounts of children displaying mental advantages from simultaneous exposure to two languages. The most notable case study came from Leopold (1949) who claimed that exposing his daughter named Hildegard to two languages enhanced her mental development. He theorized that bilingual children are able to focus on the content of words rather than their forms because bilinguals learn early on the abstractness and symbolism of words as they have to separate two different words for each referent.

"Monolingual is the person who is able to speak only one language" (Macquarie Dictionary) or it is said of a person/community with only one language, also called unilingual (Crystal, 1987). It has also been defined as "a person who knows and uses only one language. A monolingual is a person who has an active knowledge of only one language, though he has a passive knowledge of others (Richards and Schmidt, 2002). Other terms are monoglot "one who speaks, writes or understands only one language"

(Shorter Oxford Dictionary) or 'unilingual', which Crystal (1987) proposed as a synonym for monolingual. On the other hand bilingualism has been defined as 'knowing two languages' (Valdez and Figueora, 1994). However, a cardinal issue is to understand the connotation of the phrase 'know a language'. A bilingual person may possess high proficiency in both the languages or one of the two languages may be the dominant (preferred one). Thus bilingualism shows a scale of gradation which should be considered in classifying the phenomenon.

Peal and Lambert (1962) set new methodological standards (of their time) in research on bilinguals which required measuring language proficiency in both first and second language. They pointed towards the importance of controls for both socio-economic status and for language proficiency of bilinguals in research. Their methodological standard required sampling only among "balanced bilinguals" with proficiency in both the first and the second language and contrasted them with monolingual students from the same school. Both the groups were middle class students. In Peal and Lambert's study (1962), bilinguals outperformed monolinguals on verbal and non verbal measures particularly in tasks that required mental or symbolic flexibility. This was the first study to demonstrate the advantages of bilinguals in terms of "cognitive flexibility" (Hakuta, 1986). In the tradition of basic research, many studies built further upon the methodological standards and the theory of cognitive advantages of bilingualism developed Lambert (1974). Just as negative associations between bilingualism and cognition were based on faulty methodology, research on cognitive advantages has also been criticized for its methodological shortcomings (Reynolds, 1991). For research on "balanced" bilingualism randomness of the sample is a methodological flaw that is hard to overcome (Reynolds, 1991). The cognitive advantages shown by balanced bilinguals may be biased by such factors as parental attitudes, experiences and motivation (Baker, 1993). The cause and effect relationship is hard to determine. Are the cognitive advantages due to bilingualism or is it that balanced bilingualism is a result of cognitive advantages? Hakuta (1986) also argues that the level of researcher's motivation may affect the results of the study. Despite these flaws, positive consequences show what is "possible" with balanced bilinguals under positive circumstances and this line of research merits further attention.

Keeping in mind the available literature cognitive abilities viz., intelligence, problem solving ability, concept formation and creativity were taken into consideration. A clear cut answer regarding the role of lingualism in the development of cognitive abilities is not yet available. Different studies clearly indicate conflicting results. Some of the studies have shown that bilinguals outperform monolinguals in all the above listed cognitive abilities whereas other researchers have shown that monolinguals perform better than bilinguals in certain cognitive abilities. For some scholars the bilingual effect is positive (Alterriba & Heredia, 2014; Bubalo, 2011;Yoshida, 2008), others say negative (Bialystok, Craik, & Luk 2008; Gollan, Montoya, Cera, & Sandoval 2008; Gollan, Fennema Notestine, Montoya, & Jernigan 2007; Luo, Luk, & Bialystok 2010; Sandoval, Gollan, Ferreira,& Salmon 2010), and still others look at specific areas of interest impact, saying bilingualism has both positive and negative effects (Engel de Abreu, 2011). Therefore bilingualism has been the relevant topic for years. Present study was designed with an objective to compare cognitive abilities of Monolinguals and Bilinguals and to Estimate the Reliability coefficients for all the variables used in the study using split-half, test-retest and inter-scorer methods. Bilingual children performed better than monolingual children on both verbal and non verbal tests of intelligence and that bilinguals were highly good on certain subtests which require mental manipulation and reorganization of visual patterns (Romaine,1989; Edwards, 1995).Based on these findings, Peal & Lambert (1962), concluded that bilingual child had "mental flexibility", superiority in concept formation

and a more diversified set of mental abilities, but they also pointed out that it is not possible to state from the present study whether the more intelligent child become bilingual or bilingualism aided his intellectual development. It has been found that the bilingual child has a better awareness of language difference, he/she is better at learning new languages, and possesses important advantages in intelligence and cognitive growth (Grosjean, 1982; Gonzales & Yawkey, 1994; Hawson 1997; Murray & Kouritzin, 1997; Roseberry-McKibbin & Brice, 2000).Thus, in contrast to studies conducted in earlier period the later period of 20th century was marked by overwhelmingly positive findings regarding the relationship between bilingualism, intelligence, cognitive abilities and linguistic development. To examine whether theory of mind (ToM) development differs in bilingual and monolingual preschool children Farhadian, Abdullah & Mansoretal (2010) conducted a study in which three false belief tasks were given to 163 Kurdish-Persian bilingual and Persian monolingual preschool children. Bilingual children performed significantly better than monolingual children in their ToM (theory of mind) when age and verbal ability was controlled. Hierarchical multiple regression analysis revealed that, bilingualism contributed significantly to the prediction of preschoolers' theory of mind development. Braun (2007) confirmed that bilinguals have an edge over monolinguals in acquiring the literacy skills and having more success in school by conducting an analysis of reading comprehension on French-speaking Belgium children who followed a Dutch immersion type program. Bilingualism plays a supportive role in second language learning was investigated by Mustapha (2012). He examined the bilinguals and monolinguals' performance in English language learning in Nigeria. Terminal results in English Language tests of 108 Yoruba/English bilinguals and 108 Nigerian English monolinguals at the Senior Secondary School level were compared. Findings revealed that more bilinguals are found in the pass region than monolinguals or more monolinguals were found in the fail region than bilinguals. These results confirmed the position that bilingualism plays supportive role in second language learning, especially in second language situation. As a result, stakeholders in second language learning might need to strengthen the learning and use of bilinguals' first language in order to enhance effective second language learning. Bialystok (2005 & 2009) found that bilinguals outperformed their monolingual counterparts on the nonverbal tasks requiring control processes such as selective attention to relevant aspects of a problem, inhibition of attention to misleading information, and switching between competing alternatives. Bilingual children tended to solve problems that contain conflicting or misleading cues at earlier age than monolinguals (Bialystok & Martin, 2004). They were also better at identifying the alternative image in reversible figures (Bialystok & Shapero, 2005). Moreover, the studies with older bilinguals showed that this cognitive advantage persists into adulthood. Bilingual young adults needed less time than their monolingual counterparts to resolve the conflict between the target stimulus and the to-be-ignored flanker information (Costa, Hernandez & Sebastian-Galles, 2008). Millett (2010) investigated that bilingualism has a broader effect on mental state reasoning In a study to access the possible effect of blingualism on creativity in non-mathematical and mathematical problem solving among very young bilingual and monolingual pre-schoolers and concluded that both early bilingualism and some form of bilingual or formal education seem to influence the child's general and mathematical creativity (Sehic, 2016). Researchers investigated that second learners skills are virtually related to all the measures of creativity and they also show that bilinguals are significant in cultural diversity and travelling experiences (Frust and Grin, 2017). A study conducted by Strome, Celik, Camagro, Forthman, Holling and Lubart (2017) showed that the impact of forced language switching on originality of producing ideas during divergent thinking task, the subjects who switched language and those who were one language

speakers were randomly assigned to perform alternate uses task and it was found that subjects who switched languages generate more original and novel ideas in comparison to subjects who cannot switch between two languages. Hernandez et al. (2018) also found that bilinguals were better at solving math problems that required complex problem-solving skills compared to monolinguals. . Kroll, Takahesu Tabori, and Navarro-Torres (2021) identified and viewed bilingualism as a skill with good impact on cognition and problemsolving abilities. Most studies investigating the cognitive benefits of multilingualism have focused on children or young adults (Bialystok, 2017). However, it is suggested that the cognitive advantages of multilingualism persist throughout the lifespan, with older adults also demonstrating enhanced cognitive flexibility and executive function. Moreover, recent studies have shown that multilingualism may even delay the onset of age-related cognitive decline and dementia (Bialystok & Poarch, 2014). Yang et al. (2022) explored bilinguals who show improved executive function and cognition which play an important role for problem-solving.

METHODOLOGY

A sample of 200 monolingual subjects (100 boys and 100 girls) and 200 bilingual subjects (100 boys and 100 girls) were selected from different public schools of district Amritsar. While selecting the sample, socio-economic status, age of the subjects and the degree of monolingualism and bilingualism were taken into consideration. Language proficiency was assessed by reading, writing, speaking and understanding skills of the language. The students, who read, write, speak and understand only one language at all the places viz., school, home, family and friends were considered as monolinguals. On the other hand, those who can read, write, speak and understand more than one language at school, home and in company of friends were considered as bilinguals. The age range of the subjects along with Means and Standard Deviations has been given in the Tables 1 to 3. All the subjects belonged to8th grade having completed 7 years of formal education. In the present study some important variables such as socio-economic status, sex, degree of lingualism, age and the actual test used (which play a crucial role in data analysis) which may have significant effects on the results were sufficiently controlled. All the subjects were divided into groups on the basis of degree of lingualism. Since subjects had varying abilities to read, write and speak different languages, so two groups of monolinguals and bilinguals were constituted to compare cognitive abilities.

Table no.1.Frequency Distribution of Age Range of Monolinguals and Bilinguals (Monolinguals: N=200, Bilingual: N=200)

C.I.	**MONOLINGUALS** **F**	**BILINGUALS** **F**
14-	79	76
13-14	99	97
12-13	22	27
M	**13.28**	**13.24**
S.D.	**0.65**	**0.68**

MEASURES USED

The tests used in the study are well known and have quite often been used by various investigators in India and abroad. It is therefore, not necessary to give detailed information of these measures, however a

brief review describing the salient features of the following measuring instruments is given below:

1. Language Proficiency Test, (Kharkhurin,2005)
2. Standard Progressive Matrices (Raven,1984)
3. Problem Solving Ability Test, (Dubey, 2011)
4. Concept Formation Test,(Hoffmann and Kansanian, 2005)
5. Torrance Test of Creative Thinking, (TTCT: Torrance et al., 2002)

RESULTS

COMPARISON OF MEANS

The total sample of the study was divided into four groups i.e. Monolingual Boys (MB: N=100), Monolingual Girls (MG: N=100), Bilingual Boys (BB: N=100) and Bilingual Girls (BG: N=100). To find out significant differences between Monolingual and Bilingual individuals, the four groups were clubbed together into two groups i.e. Monolinguals (ML: N=200, 100 Boys and 100 Girls) and Bilinguals (BL: N=200, 100 Boys and 100 Girls). Each group comprised of 200 subjects and gender was ignored while clubbing the groups. To find out the significant differences between Monolinguals and Bilinguals a univariate t-test was applied (Guilford, 1973). The t-test indicates the statistical significance of differences between two independent group The table no.1 clearly depicts the significant differences between bilinguals and monolinguals on test of intelligence. The values indicated that bilinguals (M=44.58) have scored higher on Raven's test of intelligence than monolinguals (M=26.80). The values on Problem Solving Ability test clearly indicates that bilinguals (M=9.05) scored higher in comparison to monolinguals (M=5.24). The mean difference between bilinguals (M=.5.17) and monolinguals (M=52.42) on verbal fluency is quite evident. The mean (M= 26.84) values indicate that bilinguals (M= 37.78) scored higher on verbal flexibility than monolinguals. Table no.1 shows significant differences between bilinguals and monolinguals on verbal originality. The values signifies that bilinguals (M=56.03) scored higher than monolinguals (M= 28.70). The values in the table on verbal elaboration indicates that bilinguals (M=20.00) scored higher than monolinguals (M=10.02). On all the measures of verbal creativity bilinguals have an edge over monolinguals. On the other hand the results evidently indicate that bilinguals again have an upper hand than monolinguals in figural creativity. Bilinguals with (M=30.48) scored higher on figural fluency than monolinguals with (M=19.70). Bilinguals (M=23.62) scored higher on figural flexibility as compared monolinguals (M=16.00). From the values in the table it is found that bilinguals (M= 43.64) have scored higher on figural originality than monolinguals (M=28.22). Significant differences between bilinguals and monolinguals have been found on figural elaboration as bilinguals (M=39.14) scored higher than monolinguals (M=27.98).

Table No. 1. Showing Mean, Standard Deviations and t-ratios of Monolinguals and Bilinguals along with Level of Significance (ML: N=200, BL: N=200)

S. No	Variable	Bilingual		Monolingual		t-ratio	Level of significance
		M	S.D	M	S.D		
1.	Intelligence	44.58	8.78	26.80	11.30	17.58	.001
2.	Problem Solving Ability	9.05	3.22	5.24	2.20	13.83	.001
3.	Concept formation (Correct Response)	10.54	7.88	11.45	7.57	1.20	N.S
4.	Concept formation						

	(Wrong Response)	5.14	5.55	9.60	10.92	5.15	.001
5.	Concept formation (Total Time Taken)	140.12	99.54	156.04	147.08	1.27	N.S
6.	Verbal Fluency	65.17	21.83	52.42	21.58	5.87	.001
7.	Verbal Flexibility	37.78	14.24	26.84	8.17	9.43	.001
8.	Verbal Originality	56.03	20.55	28.70	12.29	16.14	.001
9.	Verbal Elaboration	20.00	9.16	10.02	6.14	12.81	.001
10.	Figural Fluency	30.48	7.96	19.70	7.22	14.18	.001
11.	Figural Flexibility	23.62	5.86	16.00	5.46	13.45	.001
12.	Figural Originality	43.64	15.91	28.22	16.54	9.51	.001
13.	Figural Elaboration	39.14	17.99	27.98	17.44	6.30	.001

ML=Monolingual, BL=Bilingual

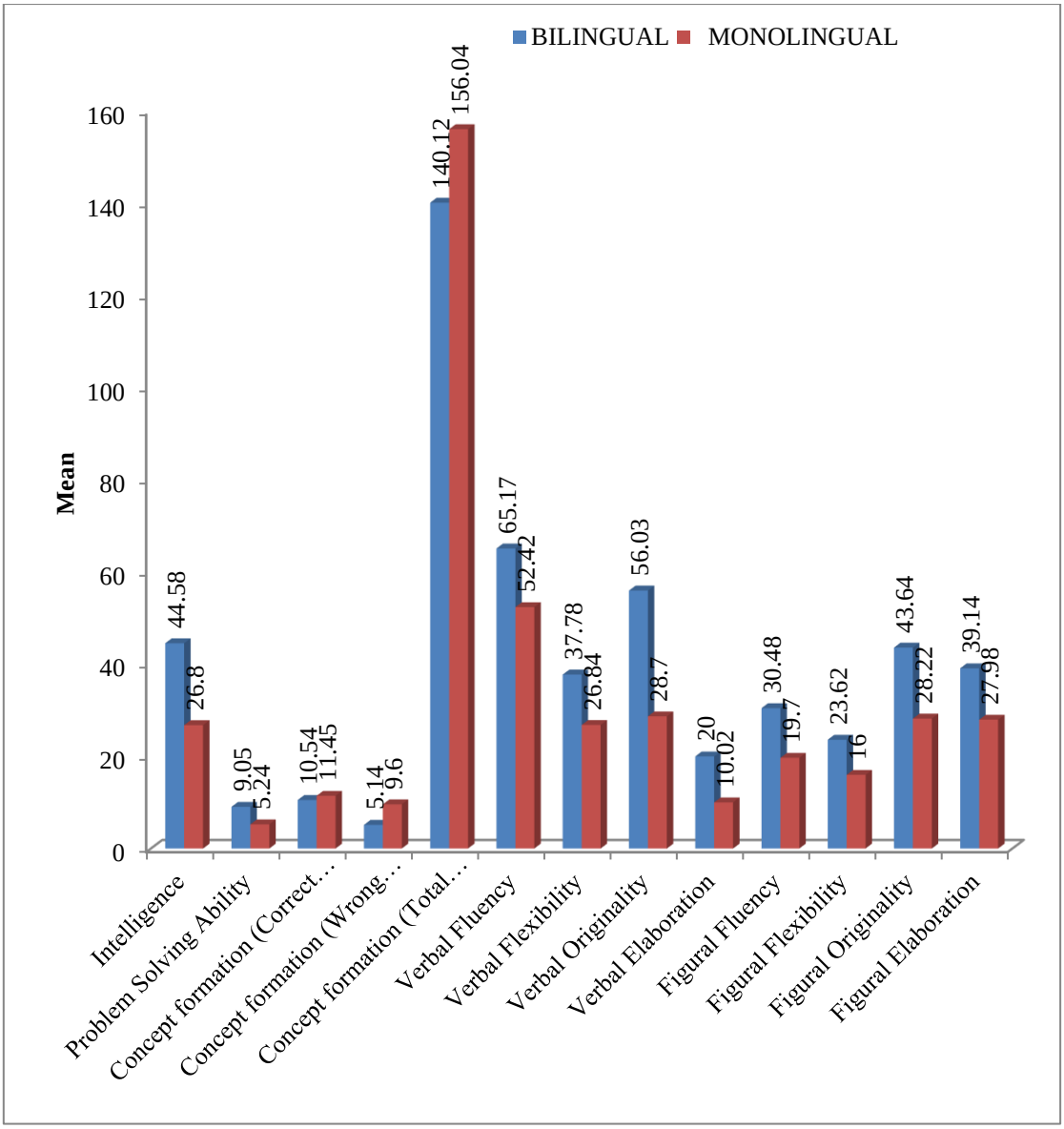

Figure No. 1. Bar Graph Showing Mean Scores on all the measured variables of Monolinguals and Bilinguals.

RELIABILITY OF TEST MEASURES

All the tests were administered in single and in groups of 5-10 subjects: (i) Raven's Standard Progressive Matrices, (ii) Dubey Problem Solving Ability Test, (iii) Hoffman and Kansanian Concept Formation Block Test, (iv) Torrance test of verbal creativity and (v) Torrance test of figural creativity. All the test measures were administered in three sessions according to the convenience of the subjects. Before administering the tests, a good rapport was established with the subjects and they were assured of the confidentiality of their responses. The tests were administered on single and in groups of 8-10 subjects in 3 sessions. In the first session, the monolinguals and bilinguals were identified through the administration of language proficiency test. In the second session, standard progressive matrices, problem solving ability test and Torrance test of creative thinking were administered in a group of 8-10 subjects with the gap of 10-15 minutes. In the final session the test of concept formation was administered on individual subjects in a separate room provided by the school. The subjects were given instructions as per the respective manuals. All the subjects were given Raven's Standard Progressive Matrices, Dubey Problem Solving Ability Test, Torrance test of verbal creativity, Torrance test of figural creativity and Concept Formation Block test. After computing Means, Standard Deviations, Skewness and Kurtosis for all the 11 variables namely, Intelligence, Problem solving ability, creativity and concept formation were computed. Reliability coefficients were estimated for all the measures using split-half, test-retest and inter-scorer methods.

Reliability refers to the degree of consistency or agreement between two sets of independently derived scores. In order to obtain reliable results, it is necessary to estimate the reliability of all the measures used in the investigation. Different methods have been administered to estimate the reliability of different measures. A total sample of 120 subjects (MB: N=30, MG: N=30, BB: N=30 and BG: N=30) was randomly selected and Reliability coefficient of Raven's Standard Progressive Matrices test (an intelligence test) was computed by Split-half method on the above stated sample. The reliability coefficients range from 0.75 to 0.92. Same method was used to estimate the reliability of Problem Solving Ability test and reliability coefficients range from 0.38 to 0.57.

The reliability coefficients of Intelligence test and Problem Solving Ability test of monolingual boys, monolingual girls, bilingual boys, bilingual girls, a combined sample of monolingual boys and girls (Monolinguals) and a combined sample of bilingual boys and girls (Bilinguals) are reported in (Table 2.1). A total sample of 40 subjects was taken and test-retest method was applied to measure the reliability of Hoffman & Kansanian Test of Concept Formation on measures of correct responses, wrong responses and time taken and the reliability coefficients came out to be 0.86, 0.89 and 0.85 respectively (Table no.2.1).

The values of reliability coefficients of Torrance test of Verbal Creativity and Figural Creativity were computed separately for fluency, flexibility, originality and elaboration by test-retest method and the same has been reported in the table no.2.2 Torrance test of Verbal and Figural Creativity is an important test. Since the scoring of the test is subjective, it was felt that inter-scorer reliability should be calculated. Keeping in mind importance of the test, a total sample of 60 subjects was selected randomly (Monolinguals: N=30 and Bilinguals: N=30). Scoring of the test was performed separately for Monolinguals, Bilinguals and on the combined sample. The scoring was done independently by two evaluators and the results have been reported in the Table no.2.3.The values range from 0.73 to 0.99 which are quite high and clearly indicate that scoring of the test is highly reliable.

Table No.2.1 Reliability Coefficients of Intelligence and Problem Solving Ability Tests (Split-half Method)

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VARIABLE	MB	BB	MG	BG	TOTAL SAMPLE	
INTELLIGENCE	0.92	0.81	0.75	0.89	MONOLINGUALS	BILINGUALS
					0.86	0.85
PROBLEM SOLVING ABILITY	0.38	0.42	0.57	0.57	MONOLINGUALS	BILINGUALS
					0.32	0.37

Table No. 2.2. Reliability Measures of Concept Formation, Torrance Test of Verbal and Figural Creativity (Test-retest Method)

Variable	Reliability coefficient	Method used
Concept formation (Correct responses)	0.86	Test-Retest reliability
Concept formation (Wrong responses)	0.89	Test-Retest reliability
Concept formation (Time taken)	0.85	Test-Retest reliability
Verbal fluency	0.97	Test-Retest reliability
Verbal flexibility	0.92	Test-Retest reliability
Verbal originality	0.92	Test-Retest reliability
Verbal elaboration	0.98	Test-Retest reliability
Figural fluency	0.93	Test-Retest reliability
Figural flexibility	0.91	Test-Retest reliability
Figural originality	0.93	Test-Retest reliability
Figural Elaboration	0.76	Test-Retest reliability

Table No.2.3. Inter-scorer Reliability of Torrance Test of Creative Thinking (TTCT)

Groups	VFL	VFE	VOR	VEL	FFL	FFE	FOR	FEL
BILINGUALS (N=30)	0.96	0.96	0.99	0.94	0.88	0.94	0.94	0.94
MONOLINGUALS(N=30)	0.95	0.89	0.84	0.73	0.97	0.96	0.99	0.99
COMBINED DATA(N=60)	0.95	0.93	0.89	0.91	0.94	0.96	0.96	0.96

VFL=Verbal Fluency, VFE=Verbal Flexibility, VOR=Verbal Originality, VEL=Verbal Elaboration, FFL=Figural Fluency, FFE=Figural Flexibility, FOR= Figural Originality, FEL=Figural Elaboration

DISCUSSION

Bilingual students perform better than monolingual students on intelligence test which shows that learning of second language improves intellectual abilities of the students. Bilingual students have shown better problem solving abilities than monolingual students which shows that learning of two or more than two languages promote unique problem solving techniques that help the students to solve complex problems easily and quickly. Monolinguals gave a greater number of wrong responses as compared to bilinguals which means that the process of concept formation is more problematic among monolinguals. Bilingual students performed better on all the components of verbal and figural creativity as compared to the monolingual students which means that, as compared to monolinguals, bilinguals are more creative. Our results clearly indicate that bilingual students, as compared to monolingual students, have better intellectual and problem solving abilities. They are more creative and the process of concept formation for them is relatively easy and quick. Different studies in past have shown similar result patterns as Lambert and Anisfed (1969) established a positive relationship between bilingualism and intelligence and found that bilinguals were superior on both verbal and non verbal tests of intelligence when socio economic status was controlled. They further argued that, as compared to monolinguals, diversified socio-linguistic background of bilinguals favours the development of a more complex structure of mental abilities. A study by Oller (1981) also stated that knowledge of language is the principle basis of intelligence. Intelligence has been considered as one of the important factors affecting learning in general and learning of languages in particular. (Hernandez, 1983; Tuck, 1983; Clarkson and Glabraith, 1992) supported the positive relationship between bilingualism and mathematical skills. Many researchers examined the effect of degree of bilingualism in mathematical word problem solving and shown that the balanced bilinguals demonstrated their mental flexibilities when faced with challenging mathematical word problems expressed in two languages of testing. The results of the present study are in close agreement with Bialystok (2005, 2009) which showed that bilinguals outperformed their monolingual counterparts on non-verbal tasks requiring control process such as selective attention to relevant aspects of a problem, inhibition of attention to misleading information and switching between competing alternatives. . Carringer (1974) found that high school Spanish-English bilingual students scored higher than monolingual students on verbal and figural creativity measures. One cause of increase in creativity may be the flexibility that is required to frequently switch languages and cultural behaviours (Walters, 2005). Li (2014) found that bilingual individuals showed superior problem-solving skills compared to monolingual individuals, but this effect was weaker in individuals who learned their second language later in life. This suggests that the relationship between multilingualism and cognitive abilities may be stronger in individuals who learn multiple languages at an earlier age. DeLuca and Rosen (2022) identified individuals who spoke more than two languages had enhanced cognitive flexibility and problem-solving skills. Ghonsooly (2012) investigated the possible influence of foreign language learning on individual's divergent thinking abilities. The subjects were compared on the Torrance test of creative thinking. The findings revealed that learning English as a foreign language to an advanced level significantly enhances all the four divergent thinking abilities i.e. fluency, elaboration, originality and flexibility. Walters (2005) found that higher score on flexibility may be attributed to the fact that flexibility is required for students to frequently switch languages and cultural behaviours. Kharkhurin (2008) found that bilingual participants outperformed their monolingual counterparts on elaboration in divergent thinking. Bilinguals outperformed monolinguals on all these components (Fluency, Flexibility, Originality and Elaboration) of verbal and figural creativity. Kroll, Takahesu

Tabori, and Navarro-Torres (2021) identified and viewed bilingualism as a skill with good impact on cognition and problem-solving abilities.

Reliability, like validity, is a way of assessing the quality of the measurement procedure used to collect data in a dissertation. In order for the results from a study to be considered valid, the measurement procedure used in study must be reliable. The supposition, that the variable we are measuring is stable or constant, we need to compute reliability. Most important of all, a measurement procedure that is stable or constant should produce the same (or nearly the same) results if the same individuals and conditions are used. In the present study we have calculated different measures of reliability for different measures used. The split half method has been administered to calculate the reliability coefficient of intelligence and problem solving abilities where reliability coefficients of intelligence test are quite high. On the other hand test-retest reliability coefficients of concept formation test are on higher end. Results of test-retest method for verbal test of creativity and inter-scorer/rater reliabilities for Torrance figural test of creativity are also quite high.

CONCLUSIONS

Bilingual students performed better than monolingual students on intelligence test which shows that learning of second language improves intellectual abilities of the students. Bilinguals have shown better problem solving abilities than monolingual students which shows that learning of two or more than two languages promote unique problem solving techniques that help the students to solve complex problems easily and quickly. Monolinguals gave a greater number of wrong responses as compared to bilinguals which means that the process of concept formation is more problematic among monolinguals. Bilingual students performed better on all the components of verbal and figural creativity as compared to the monolingual students which means that, as compared to monolinguals, bilinguals are more creative. Our results clearly designate that bilingual students, as compared to monolingual students, have better intellectual and problem solving abilities. They are more creative and the process of concept formation for them is relatively easy and quick. A total sample of 40 subjects was taken and test-retest method was applied to measure the reliability of Hoffman & Kansanian Test of Concept Formation on measures of correct responses, wrong responses and time taken and the reliability coefficients came out to be 0.86, 0.89 and 0.85 respectively which is on higher end. Since the scoring of the Torrance test of creativity is subjective, inter-scorer reliability was calculated by two different scorers. The values range from 0.73 to 0.99 which are quite high and clearly indicate that scoring of the test is highly reliable.

IMPLICATIONS

The present study confirmed that bilinguals have outperformed monolinguals in various cognitive abilities.

The reliability coefficients calculated for different measures used in the study are quite high and reliable in the present study.

LIMITATIONS

We can use other statistical tool in addition to t-test for comparing group of Bilinguals and Monolinguals to reach more concrete results.

Although the current study suggests strong test-retest reliability for the different measures used but it should be acknowledged that these findings are limited in several specific ways to the demand of the stu-

dy.

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