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Full Length Article

Effect of bilingualism on Working Memory of Turkmen students in Iran

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ABSTRACT
This study explored the effect of bilingualism on visuospatial and verbal aspects of working memory in Iranian Turkmen students. One hundred students were randomly assigned into monolingual (N=50) and bilingual (N=50) groups. The students were 11-13 years old and they were from both genders. There was no significant difference in intelligence quotient (IQ) between the two groups. Visuospatial memory was determined via two tasks, i.e. Do Matrix and Odd-One-Out; verbal memory was measured by Forward Digit Recall and Backward Digit Recall. Since there were no significant differences in memory scores between boys and girls and among different ages, these factors as well as IQ were not considered covariates. The results of independent-samples t-test and ANOVA revealed that bilinguals only outperformed significantly in the Odd-One-Out task. There were no significant differences in verbal working memory between monolinguals and bilinguals. This indicates the varying effects of bilingualism on working memory.
Keywords: *Bilingualism, working memory, students, Iranian Turkmen.*

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INTRODUCTION

Bilingualism is considered a positive factor in order to develop cognitive abilities in children [1]. Its function is through the induction based on experience by considering the target language when simultaneously activated along with of the other language [2]. It has been substantially proven that both languages in bilinguals play rather active roles in production and comprehension [3-5]. This fact might have several effects on psychological and learning characteristics of bilinguals [6-8].

Working memory is regarded as a type of memory adopted for both storing and processing information [10]. Baddeley [9] further defined working memory as a subsystem of memory consisting of two distinctive functions running at the same time; these functions include storing information temporarily and controlling processing of information. Bharadwaj [11] explained that working memory consists of an active system in which information storage occurs in mind; the stored information is subjected to internalization and when this stage is completed, it is assembled and transformed in a way after manipulation; the manipulated information is then adopted in its new form. It is widely known that information storage, as one of the distinct functions of working memory, takes place in two slave systems, i.e. visual cache and phonological store; the former is mentioned for visuospatial information while the latter is for verbal information [8, 12].

Working memory is particularly important for children at school age since it has a direct relationship with generation of inference and hence learning process [13]. Maehler & Schuchardt [14] reported that working memory has a direct relationship with capability of students in doing their academic tasks. In addition, it has been proven that bilingual children have a better performance than monolinguals in terms of their visuospatial working memory [15, 2, 16]. Overall, working memory can be considered to play roles in variety of cognitive processes such as language comprehension, planning, reasoning, problem-solving, and consciousness, to name a few [17].

There were a few investigations indicating that bilinguals have a better performance than monolinguals in terms of processes pertaining to working memory; these studies focused on executive functions [18, 19, 15], and language-related issues [20, 21]. Kudo and Lee Swanson [22] investigated performance difference on working memory measures in bilingual children who varied in language proficiency. They found that for children with stable bilingual status, no overall advantage on the three components of working memory was detected relative to children proficient in one or two languages. More importantly, they stated that the children could use another language in addition to their mother tongue showed better levels of working memory scores in the case of executive system and phonological loop.

Iran is a rather populated country in the Middle East housing variety of cultures and languages. Therefore, there is normally a large group of people speaking their mother tongue, e.g. Arabic, Turkish, Kurdish, Turkmen, etc., in addition to Persian, the official language of the country. Despite the large number of bilinguals in Iran and with regard to the recent emphasis of academics on the possible role of bilingualism on working memory, to the best of our knowledge, there has not been any research on the effect of bilingualism on working memory of those speaking two languages compared to that of the so-called monolinguals. The present study aimed at determining the effect of bilingualism on the working memory.

METHODOLOGY

Subjects

Fifty Iranian Turkmen students were selected through simple random sampling from the students of fourth, fifth, and sixth grades in Gorgan, one of the northern cities if Iran. The number of participants was considered suitable as it exceeded the minimum sample size calculated by the multiple regression analysis. The followings were the standards of inclusion for the participants of the study: (a) aged 11-13 years; (b) no physical and/or mental disorders; (c) not suffering from any external complications such as family problems, depression, etc.; (d) understanding the purpose of the study and a written parents' permission to participate in this study. All the participants were able to speak Persian fluently in addition to their first language of Turkmen. Furthermore, fifty monolingual Persian-speaking students with the same criteria were randomly selected as control. In addition, the children's nonverbal intelligence quotient (IQ) was measured by using Raven's Colored Progressive Matrices (Raven, 1995). IQ was determined to see if there was a significant difference in the IQs of monolinguals and bilinguals to see whether or not IQ should be considered a covariate in this study.

Measurements

Visuospatial working memory tests

Visuospatial working memory tests was designed in Persian by the author based on the Automated Working Memory Assessment (AWMA) [6] as described by Blom *et al*. [16] with some modifications. Two tests, i.e. the Dot Matrix and Odd-One-Out tasks, were adopted to determine visuospatial memory in bilingual and monolingual subjects.

In the Dot Matrix task, 4×4 matrices with red dots appearing in 2-sec intervals are shown to the subjects and they are asked to recall the coordinates of the dots. Before running the main practice, two trials were performed to make sure the subjects were completely familiar with the game. The test began first with a block including six trials where only one dot was shown; it continued to a block with six trials including seven dots across the matrix.

In the Odd-One-Out task, children are given seven groups of words or pictures, each containing 6 batches. The first group included batches with three choices which increased to nine choices in the batches of the last group. The subjects were asked to find out the different choice in each batch followed by tapping the box in which the odd-one-out shape had been given.

Verbal working memory tests

To tests were used in order to assess verbal working memory: Forward Digit Recall and Backward Digit Recall. These tasks were chosen since digit recall seems to have nothing to do with language level and proficiency of the subjects and therefore, the effect of language on the results would be minimized. The tests were administered using a tablet. Again, before running the main practice, two trials were performed to make sure the subjects were completely familiar with the procedure. The tasks started with 7 blocks, each containing six trials. The first block included numbers with three digits while one more digit was added to the numbers of the subsequent blocks so that the numbers in the last block had nine digits. In the Forward Digit Recall task, children were requested to repeat each number from left to right whereas in the Backward Digit Recall task, they were requested to repeat each number from right to left.

Procedure

All the tasks were done at a quiet room in schools. For motivation purposes, the boy subjects were given stickers and the girls were given small dolls at the end of each task. Scoring the tests was performed as explained by Blom *et al*. [16]. Briefly, for Digit Recall tasks as well as the Dot Matrix task, the answers were considered wrong if the order of digits or dots were incorrect or one or more digit(s) was/were missed or said by mistake. If 60% of the trials were answered correctly in each block, it was considered to be true. As soon as the subject answered 60% of the trials in each block, the next block commenced immediately. When each block was answered correctly, the score "6" was given to the students. The overall scores ranged from 0 to 42.

Data analyses

Data analyses were performed by using SPSS version 21 (IBM SPSS Statistics, Chicago, IL, USA). The statistical analyses were performed via independent samples t-test and one-way analysis of variance (ANOVA).

RESULTS

The objective of the present study was to analyze whether bilingualism has any significant influence on working memory of students. First, general characteristics of the subjects were taken into account to avoid negligence of external factors such as age or IQ on the results. It is noteworthy that the subjects were selected from families with rather similar socioeconomic backgrounds to minimize the effect of SES on the results. Table 1 represents the general characteristics of the subjects in the present study.

According to Table 1, the monolingual group consisted of 11 boys and 39 girls while there were 15 boys and 35 girls in the bilingual group. In monolingual group, 11-year-old students outnumbered the other students while bilinguals were mostly 13 years old. The non-verbal IQ score of the monolinguals was slightly higher than that of bilinguals. in order to find out whether there is significant difference between the IQ score of the monolinguals and bilinguals, independent samples t-test was performed and the result showed that there was no significant difference between non-verbal IQ scores of monolinguals and bilinguals ($p>0.05$). Therefore, IQ was not considered a covariate in the following analyses.

Table 1. General characteristics of the subjects

		Monolinguals	**Bilinguals**
Number		50	50
Gender	Boy	11	15
	Girl	39	35
Age (years old)	11	22	10
	12	12	12
	13	16	28
Non-verbal IQ	Mean ± SD	35.58 ± 3.41	34.28 ± 3.43
	Min	30	30
	Max	40	40

Table 2 depicts the mean working memory scores of monolingual and bilingual students in terms of their age and gender. We further analyzed whether there are significant differences in the scores between boys and girls by independent samples t-test as well as between different ages via one-way analysis of variance (ANOVA) and post-hoc Duncan's test (Table 3). Since there were no significant differences in the scores of both monolingual and bilingual students in terms of their gender and age ($p>0.05$), we decided not to consider any of the age and gender as covariate and therefore, we adopted independent samples t-test to analyze whether bilingualism has any effect on working memory of the students.

Table 2. Mean scores and standard deviations of working memory tests in monolingual and bilingual students in terms of their age and gender

		Monolingual	**Bilingual**
Boys	Dot Matrix	6.07 ± 1.24	5.93 ± 1.48
	Odd-One-Out	33.27 ± 5.00	28.60 ± 4.79
	Forward Digit Recall	13.63 ± 3.58	14.33 ± 3.77
	Backward Digit Recall	5.45 ± 2.91	4.73 ± 2.68
Girls	Dot Matrix	6.46 ± 1.87	6.57 ± 1.98
	Odd-One-Out	32.69 ± 4.73	31.37 ± 6.99
	Forward Digit Recall	14.61 ± 5.03	13.54 ± 3.38
	Backward Digit Recall	6.02 ± 2.73	4.85 ± 2.19
11 years old	Dot Matrix	7.80 ± 1.47	7.04 ± 2.05

	Odd-One-Out	28.30 ±4.42	29.81 ± 6.76
	Forward Digit Recall	13.60 ± 4.40	13.40 ± 3.43
	Backward Digit Recall	5.10 ± 2.55	4.77 ± 2.02
12 years old	Dot Matrix	6.58 ± 2.42	6.83 ± 1.26
	Odd-One-Out	25.33 ± 2.26	29.00 ± 7.39
	Forward Digit Recall	12.83 ± 4.54	14.33 ± 3.60
	Backward Digit Recall	5.33 ± 1.92	4.66 ± 0.651
13 years old	Dot Matrix	6.85 ± 1.95	6.56 ± 1.09
	Odd-One-Out	26.64 ± 2.24	33.00 ± 4.80
	Forward Digit Recall	15.07 ± 4.72	14.12 ± 3.77
	Backward Digit Recall	6.25 ± 3.07	5.81 ± 2.56

Table 3. The independent samples t-test and ANOVA results for the differences of working memory in terms of gender and age

		Monolingual	**Bilingual**
Gender*	Dot Matrix	0.076	0.271
	Odd-One-Out	0.724	0.468
	Forward Digit Recall	0.550	0.865
	Backward Digit Recall	0.550	0.169
Age**	Dot Matrix	0.347	0.667
	Odd-One-Out	0.060	0.198
	Forward Digit Recall	0.440	0.726
	Backward Digit Recall	0.540	0.217

*Independent samples t-test
**One-way analysis of variance

Table 4 represents the results obtained from independent samples t-tests for comparing the different aspects of working memory between monolingual and bilingual students. Because there were no significant differences in terms of the students' IQs, age, and gender, analysis of covariance was not required and the analysis was performed by independent samples t-test. As it can be seen, there are not any significant differences between monolingual and bilingual students in their scores of Dot Matrix and Digit Recall tasks ($p>0.05$). However, there is a significant difference between them in Odd-One-Out task scores ($p<0.05$).

Table 4. Comparing working memory test scores between monolingual and bilinguals students

	t	**df**	**sig**
Dot Matrix	0.436	97	0.664
Odd-One-Out	-3.963	68.85	0.000
Forward Digit Recall	0.248	97	0.805
Backward Digit Recall	1.288	89.70	0.201

DISCUSSION

The present study was an attempt to explore the differences in working memory aspects between monolingual and bilingual students in Gorgan, Iran. A group of 100 students from the fourth, fifth, and sixth grades of primary schools were selected; 50 students were monolingual speaking only Persian, the official language of Iran, and 50 of them were Iranian Turkmen students whose first language was Turkmen and they also could speak Persian. Since no significant differences were detected between boys and girls as well as among different age groups, age and gender were not considered covariates. The same was the case for the students' intelligence quotient scores. The results revealed that except for the Odd-One-Out task ($p<0.05$), there were no significant differences in the scores of Dot Matrix and Digit Recall tasks between monolingual and bilingual students ($p>0.05$).

The working memory tasks can be differentiated in terms of their modality and complexity. Complex tasks demand a higher level of support by the central executive system; such tasks require both storage and processing of information. It is widely known that The Forward Digit Recall and Dot Matrix tasks are storage-related tasks while the other two tasks, i.e. Odd-One-Out and Backward Digit Recall, are based upon both storage and processing [16]. In the present study, bilingualism could have a significant effect on the scores of Odd-One-Out task and therefore, we can point to the effect of speaking two languages rather than one on the ability of a person to have better performance when it comes to the tasks needing storage and processing of information. However, this conclusion is somehow blurred since no significant

difference was detected in the scores of Backward Digit Recall between the monolingual and bilingual students ($p>0.05$).

The significantly higher performance of bilingual students in the Odd-One-Out task here can be explained by the idea of May [23]. She believes that meta-lingual capability of bilinguals is a driving force for improvement of cognitive processes and learning and therefore, bilinguals adopt cognitive strategies more effectively. Furthermore, interaction between languages is a factor by which bilinguals can make a more productive use of cognitive process. Since both languages are actively interacting and have common representative areas in brain, bilinguals have higher abilities of preventive control and selective attention in cognitive processes. In addition, Bialystok and Feng [24] believe that each language is a complex of behaviors such as slangs, proverbs, tales, history, and unique traditions (e.g. greetings, wedding parties, birthday party, funerals, etc.). Each of these behaviors may render specific capabilities to bilinguals and help them experience and process different beliefs and increase their cognitive experiences and flexibility. Therefore, from an educational viewpoint, this capability along with the ability to transfer and generalize experiences, syntax knowledge, phonology, semantics, and sociocultural awareness from one language to another give complicated view and big picture to bilinguals resulting in higher educational performance. Furthermore, Kohnert [25] stated that abundance of using both languages in bilinguals plays an important role in elevation of lingual abilities of them. In other words, bilinguals can benefit from cognitive and developmental advantages of bilingualism with having the possibility of using both languages at the same conditions. Schmeichel *et al.* [26] further mentioned that due to frequent use of phonology and similar words, bilinguals recall the words of both languages easily which lead to a better working memory among them.

Nevertheless, the results of the present study showed that bilingualism does not have significant influence on verbal working memory and its effect on visuospatial working memory is not definitely substantiated since there was no significant difference between monolinguals and bilinguals in the scores of Dot Matrix task ($p>0.05$). This was surprising because in previous study, bilingualism was proved to have substantial influence on all aspects of working memory in bilinguals [16, 17, 27, 28]. Similarly, the results of this study are in complete disagreement with those of Ganschow *et al.* [21], who found that verbal working memory is stronger in bilinguals than monolinguals. Therefore, there should have been a few preventive factors among the subjects of the present study hindering the positive influence of bilingualism. Since the subjects were all chosen from the families with similar socioeconomic backgrounds, other reasons, especially the ones at schools, could explain the results. To explain this discrepancy, in a series of studies, Bialystok and colleagues [24, 29, 30, 31] pointed to the fact that bilinguals might possess a restricted range of vocabulary in addition to lower level of lexical representations. As a result, they do not have as good performance as monolinguals in verbal short-term memory tasks. However, bilinguals may have a higher ability of executive memory leading to a better performance than monolinguals in non-verbal attributes of working memory [32]. This is in a great agreement with the results of the present study.

CONCLUSION

The results of the present study recommend that bilingualism could be regarded as a double-edge sword; that is, although it could provide a higher level of non-verbal aspects of working memory, it does not have the same influence on verbal attributes of working memory and it even causes negative effects on them. The results of this study revealed that the effect of bilingualism only different aspects of working memory in Iranian Turkmen students is not as pronounced as mentioned for other groups of bilinguals in previous studies.

COMPLIANCE WITH ETHICAL STANDARDS

It is declared the present study is in a perfect compliance with ethical standards. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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