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Working Memory Skills in Kannada Monolingual and Dakhni- Kannada Bilingual Children

Working Memory Skills in Kannada Monolingual and Dakhni- Kannada Bilingual Children

Abstract

Researches conducted on bilingual information processing have provided reports on enhanced performance in non-linguistic cognitive tasks in bilinguals. There are limited studies in Indian context on executive loaded working memory skills in bilinguals. Therefore the present study aimed to compare the executive loaded working memory skills in Kannada speaking monolinguals and Dakhni- Kannada bilingual children. A sum of 120 children took part in the study. The participants belonged to two groups Kannada monolinguals and Dakhni-Kannada bilinguals. Both the groups had children in the age group of 9-10years. Adopted version of Frog matrices test was used in the present study to assess visuo spatial working memory. The results of the current study indicated that bilinguals performed better compared to the monolinguals in visuospatial working memory task.

Key words: visuospatial memory, Dakhni speakers, executive loaded

Background

Bilingualism is the ability of knowing two different languages at a single time. It is a skill that requires "acquisition of two languages that use different speech sounds, vocabulary, and the grammatical rules" (Weiten, 2010). Studies conducted on bilingual information processing have provided reports on enhanced performance in non-linguistic cognitive tasks in bilinguals. Bilingual advantages on nonverbal executive control in have been reported both in children (Bialystok, 2001; Mezzacappa, 2004; Carlson &Meltzoff, 2008) and in adults (Bialystok, Craik, Klein & Viswanathan, 2004). It has been reported that bilingual children do better than monolingual children in visuo-spatial working memory and bilingual children assign their visuospatial working memory resources more capably than the monolingual children (Bialystok, 2010 and Morales, Calvo, & Bialystok, 2013).

It has been studied that a diverse cognitively demanding experiences alter development of brain and may modify cognitive functioning (e.g., Green &Bavelier, 2003; Maguire et al., 2003; Polk & Farah, 1998). The modification to cognitive functioning typically follows from rigorous practice in a particular process entailed by the experience. For example, computer game players have higher spatial determination of visual preparing aptitude, most presumably on account of the practice acquired amid the gaming sessions (Green &Bavelier, 2003). The practice of talking in two or more languages daily is one more experience that has been appeared to deliver change in intellectual execution (Bialystok, 2009). The component through which bilingualism prompts this experience-actuated cognitive change is likely in view of the necessity to monitor attention to target language in joint enactment of the other language.

Based on a non-verbal Simon task Bialystok, Craik, Klein & Viswanathan (2004) reported that in comparison of bilingual and monolingual adults in the age range of 30–80years bilingual participants outperformed monolinguals when working memory demands were more, and the amount of the difference was relative to age. Bilingual working memory advantage was also reported by Morales Calvo, & Bialystok (2013). The authors used two experiments with children Simon-type task and visual-spatial task. Findings demonstrated that bilinguals better than monolinguals in every one of the conditions involving high working memory and executive demands. Likewise, the bilingual children examined by Blom, Küntay, Messer, Verhagen &Leseman (2014) showed better performance in verbal (Forward Digit Recall/Backward Digit Recall) and visuospatial (Dot Matrix/Odd-One-Out) working memory tests when vocabulary was controlled for tasks that involved processing along with not just storage.

Vandana, Changappa S and Jahan (2013) compared cognitive linguistic performance of Kannada monolingual and Kannada English bilingual participants in three age groups namely 20-40years, 40-60years and 60-80years. Bilinguals showed better performance than monolinguals on non-linguistic tasks. In the age group of 40-60years and 60-80years, bilinguals showed better response for both linguistic and non-linguistic tasks compared to monolinguals.

The Phonological Working Memory (PWM) in simultaneous and sequential Kannada-English bilingual children in the age range of seven to eight years was investigated by Shylaja, Abraham, Ansu, Thomas, Grace, Swapna (2011). A Kannada based non-word repetition task (NWR) was used. Sequential bilingual children outperformed than simultaneous bilinguals on 4-syllable, 5-syllable and on overall accuracy of nonword repetition task. Findings also demonstrated better phonological working memory skills in sequential bilinguals compared to simultaneous bilinguals that were attributed to the age of language learning and on the quantity language exposure and use of the two languages.

Bialystok and Viswanathan (2009) used a behavioral version of an anti-saccade task, called the 'faces task', developed by Bialystok, Craik, & Ryan (2006) to assess three components of executive control namely response suppression, inhibitory control, and cognitive flexibility. They surveyed three gatherings of 8years old kids which included monolinguals in Canada, bilinguals in Canada, and bilinguals in India. Even though there was no significant difference between the groups in response suppression on a control condition that did not involve executive control the bilingual children in both settings were faster than monolinguals in conditions based on inhibitory control and cognitive flexibility. The kids in the two bilingual groups performed comparably to each other and uniquely in contrast to the monolinguals on all measures in which there were group differences. Subsequently the authors contended that bilingualism is in charge of upgraded executive control.

Steby, Sindhupriya, Mathur & Swapna (2010) evaluated the performance of 12 Kannada- English bilingual children and 12 Kannada monolingual children in the age range of 7-8 years on cognitive-linguistic tasks. The Cognitive Linguistic Assessment Protocol for Children (CLAP-C) (Anuroopa & Shyamala, 2008) for children was performed on the selected subjects. It was accounted that bilingual subjects were better than monolinguals on every subtask assessed in CLAP-C (attention/discrimination, memory and problem solving). Authors of the study posited clear cognitive-linguistic gain in bilinguals than monolinguals and argued that bilingualism encourages the development of cognitive-linguistic functions in youngsters.

There are limited studies in Indian context on executive loaded working memory skills in bilinguals. Therefore the present study aimed to compare the executive loaded working memory skills in Kannada speaking monolinguals and Dakhni- Kannada bilingual children.

Materials and Method

Participants

A sum of 120 children took part in the study. The participants belonged to two groups Kannada monolinguals (n=60) and Dakhni-Kannada bilinguals (n=60). Both the groups had children in the age group of 9-10years. Each group had 30 male and 30 female subjects. The subjects were included in the study based on the inclusion criteria specified below.

Subject inclusion criteria of Monolingual participants:

Language exposure: Predominantly to one language (Kannada) since birth.

Medium of instruction in school: Kannada

Language Proficiency: Proficiency 0 + Formulaic proficiency in second language English in International Second Language Proficiency Ratings (ISLPR): Wiley (2006)

Socioeconomic status (SES): Participants belonging to middle SES in National Institute for the mentally Handicapped Socio Economic Status Scale (Venkateshan, 2009)

Subject inclusion criteria of Bilingual participants:

Language exposure: Dakhni was their primary spoken language/mother tongue at home

Medium of instruction in school: Kannada

Language Proficiency: Subjects were selected based on the criteria according to ISLPR scale that is a rating scale of 'basic social proficiency' (score of 2) for Kannada language on all the macro skills to be considered as a bilingual (that is speaking, listening, reading and writing).

Socioeconomic status (SES): Participants belonging to middle SES in National Institute for the mentally Handicapped Socio Economic Status Scale (Venkateshan, 2009)

Subject exclusion criteria:

Participants with history of: speech and language delay/ impairment; visual and hearing problems; and any other neurological and behavioural problems were excluded.

Stimuli/Material

The present study aimed to investigate visuo-spatial working memory skills in bilinguals. Adopted version of Frog matrices test was used in the present study to assess visuo spatial working memory. The frog matrices task (FMT) is a computerized variation of the Corsi blocks task (Berch, Krikorian, &Huha, 1998; Milner, Corsi, & Leonard, 1991) which measures visuospatial working memory. In the present study, Frog matrices task was adapted from "Working memory development in monolingual and Bilingual children" by Morales, Calvo, A & Bialystok (2013). Frog matrices task was utilized to evaluate visuo-spatial working memory to minimize the part expected vocabulary contrasts amongst monolingual and bilingual youngsters. Frog matrices task is a span task, so working memory was surveyed by assessing the quantity of things youngsters could effectively review.

The Frog matrices task includes two presentation conditions. They are simultaneous and sequential presentation conditions. In both conditions, children were shown a 3*3 matrix on a Microsoft power point presentation and were informed that each of the nine cells represented a pond in which frogs had been resting. In the sequential presentation condition, frogs were presented one at a time and children had to remember the position of the ponds which had frogs in the same presentation order. The test had 5 levels. Each level had two trials in it. Each frog rested in the pond for 1 second. After the last frog disappeared, the child had to respond by touching each pond in which there had been a frog in the order they had been shown. The test was terminated when the subject failed to recall the position of the pond in which frog had appeared in the same presentation order. Testing began with the level of two frogs and increased by one frog after every second trial. Figure 1 shows the Sequential presentation condition.

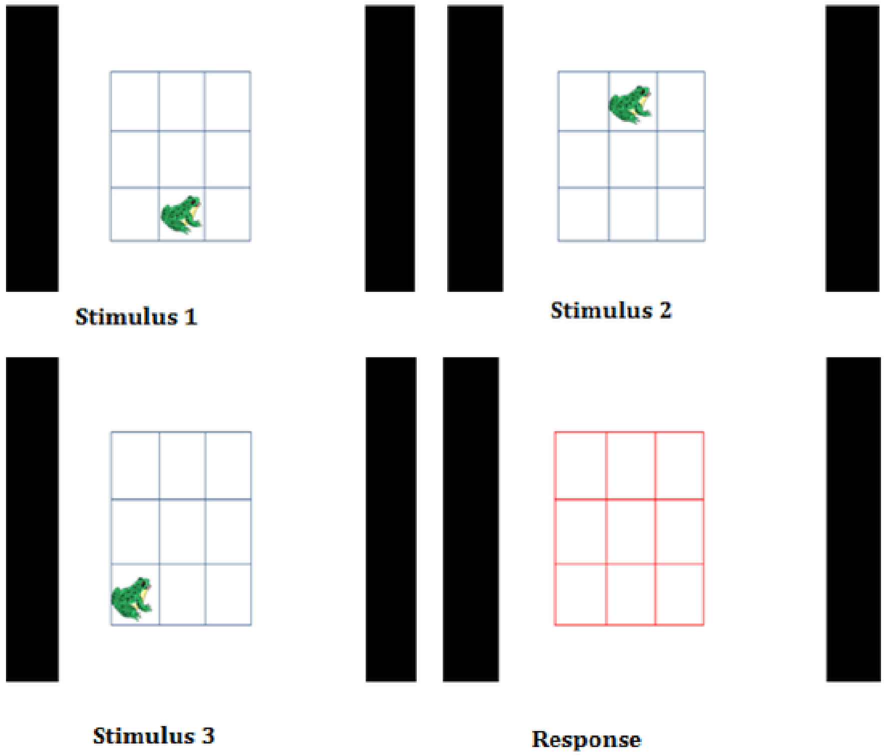

Figure1: *Sequential presentation condition*

In simultaneous presentation condition, frogs were presented as a group (at once) in the matrix which was presented on the computer screen. Children had to remember the position of the ponds which had frogs in them. The test had 5 levels. Each level had two trials in it. Level I had two frogs and the number of frogs increased to three, four, five and six for successive increase in the level. The last level (that is level V) contained six frogs in it. All of the frogs were shown for 2sec duration, followed by an empty matrix on the screen. When the empty matrix appears on the screen, the child was suppose to respond by touching the screen to point the cells that had a frog. The test was terminated when the subject failed to recall correctly the position of the pond in which frog had appeared in both trials. Testing began with the level of two frogs and increased by one frog after every next trial.

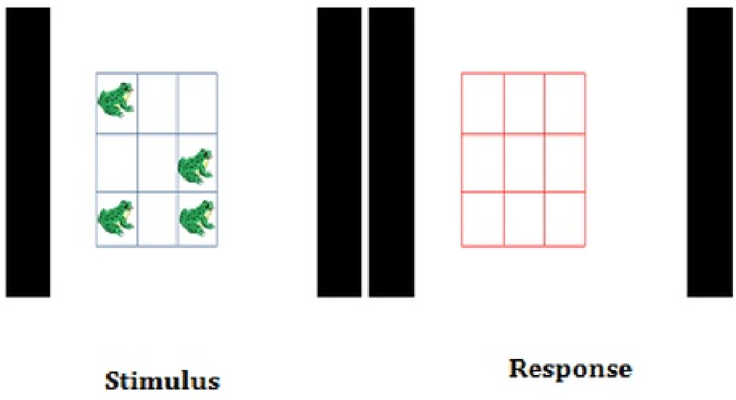

Figure 2: *Simultaneous presentation condition.*

Procedure:

One subject at a time was tested on all the tasks and scores were determined for each subject. The procedure for administration is as follows

Visuo-spatial working memory task: sequential presentation condition

The subject was seated comfortably on a chair beside the investigator in a quiet and distraction free room. Prior to commencement of the task, the examiner collected the necessary demographic data from the subject and the subject was informed that the procedure would take approximately 10-15 minutes to complete. Practice trial was given before actual testing was done.

Subjects were shown 3*3 matrix on a computer screen. Subject was instructed that each cube of the matrix resembles a pond and frogs are going to appear one at a time in each pond. They have to remember the positions of the pond in which the frogs appeared. At the end an empty matrix will be shown after which they have to indicate the positions which frogs appeared in that matrix by pointing to the computer monitor in the same order. Testing began with two frogs appearing in sequential order initially in level I followed by a blank screen for ten seconds for the subject to respond. When the child was able to recall correctly the position of the pond in which frogs appeared in one of the two trials in a level, next item of the next level was presented.

Response analysis and scoring:

The subject's responses were scored in two ways, which is sequential memory span and sequential proportion correct scores. Sequential memory span was accounted as the highest level at which 6 child remembered all of the frogs in correct order on at least one of the two trials. For example if the subjected responded correctly for both trials in level one then the sequential memory span was considered as 2.

Sequential proportion scores were obtained by dividing the total scores by the maximum possible scores for the sequential condition. 1 Total scores were the total of all frogs correctly pointed in correct order till the subject's sequential memory span. 80 was the maximum possible score for the sequential condition where 1 1 point was given for each correct position and 1 point was given for recalling that position in the correct order (40+40=80). 5 For example if the subject was correct on one of the trials containing two frogs in level 1, score of 4 (that is 2 for correct location recall of 2 frogs+2 for correct order of recall) was given and the subject continued to the next level. Again if the subject was correct in recalling the location of all the 3 frogs but missed the order of two of the frogs in that trial a score of 4 (3 for correct location recall +1 for correct order of recall) was given. Here the total scores obtained by the subject was4+4=8 (Assuming that the subject failed in another trial of second level and failed in next levels). The total scores then were converted to sequential proportion scores. Sequential Proportion scores were obtained by dividing the total scores by the maximum possible scores for the sequential condition (that is 80). The proportion scores for the given example would be 8/80=0.1.

Frog matrices test for simultaneous presentation condition

In this presentation condition also children were shown a 3*3 matrix on a computer screen. Each cube of the matrix resembles a pond, where many frogs appear at once. The frogs appear for some time on the screen and disappear. Subjects were instructed to remember the positions of the pond in which the frogs appeared. They were told that at the end an empty matrix will be shown after which they have to indicate the positions in which frogs appeared by pointing to the computer monitor after the frogs disappear. All the frogs were shown for 2sec duration, followed by a blank matrix on the screen for ten seconds. Testing began with two frogs appearing simultaneously in level I. When the child was able to recall correctly the position of the pond in which frogs appeared in one of the two trials in a level, test items of the next level was presented.

Response analysis and scoring:

Measures which were considered for scoring simultaneous presentation condition were simultaneous memory span and simultaneous proportion correct scores. The procedure to obtain simultaneous memory span and simultaneous proportion correct scores was same as that mentioned in sequential presentation condition. However the maximum possible score considered for calculating simultaneous proportion correct scores were 40 (as the presentation order was not considered in this condition). Therefore simultaneous proportion scores were obtained by dividing the total scores with the maximum possible scores (that is 40).

Statistical Analysis:

The scores obtained for visuospatial working memory (Frog matrices task) were tabulated and statistically analysed using the SPSS software (version 17.0). Descriptive and inferential statistics were carried out. As a part of descriptive statistics mean and standard deviation were obtained and as a part of inferential statistics Multivariate tests were carried out. Multivariate tests were carried out to find the differences in the performance between the groups (monolinguals and bilinguals), gender (male and female) and interaction within the gender and groups for visuospatial working memory task. The results of the study are presented below.

Results:

The results of simultaneous and sequential presentation conditions of Frog matrices test were scored in two ways: memory span and proportion correct scores. Memory span score for sequential and simultaneous presentation condition was referred to as sequential span scores and simultaneous span scores .Sequential proportion scores and simultaneous proportion scores are the proportion correct scores of sequential and simultaneous presentation condition of visuospatial working memory respectively.

Table1 and Figure 3 depict the mean and standard deviation of sequential span and sequential proportion scores of Frog matrices test in monolingual group across gender. The mean values of sequential span scores in males and females were 5.20 and 4.87 with a standard deviation of 0.76 and 0.82 respectively. The mean values of sequential proportion scores in males and females were 0.79 and 0.76 with a standard deviation of 0.05 and 0.10 respectively. Results show that males had higher mean values for both sequential span and sequential proportion scores compared to females in monolingual group.

Table 1: Mean scores of Sequential span and Sequential proportion values in Frog matrices test for monolingual group across the gender.

Gender		Sequential span	Sequential proportion

Male	Mean	5.20	0.79
	SD	0.76	0.05
Female	Mean	4.87	0.76
	SD	0.82	0.10

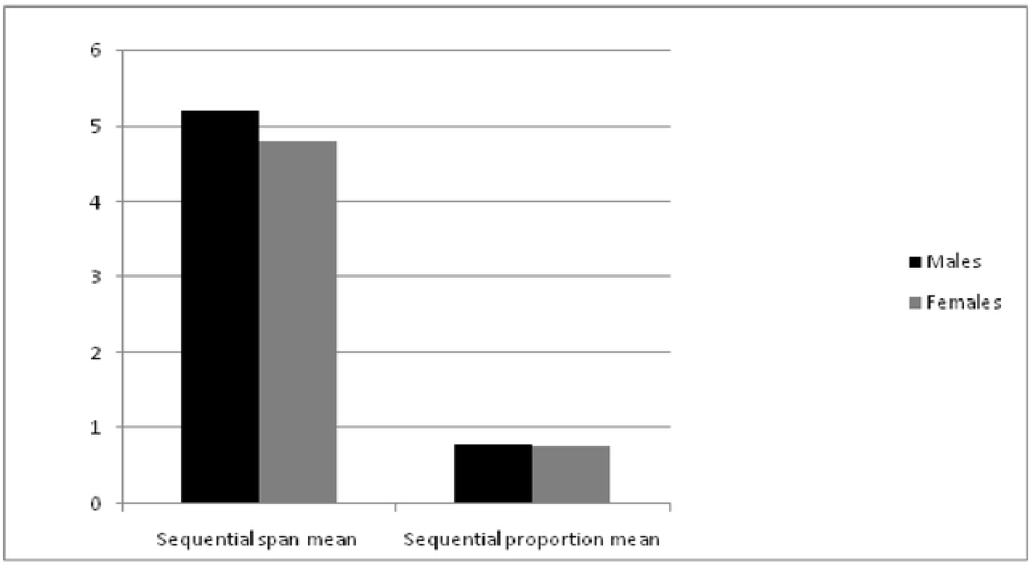

Figure 3: Mean scores of Sequential span and Sequential proportion scores in Frog matrices test for monolingual group across the gender

Table 2 and Figure 4 shows the mean and standard deviation scores of Simultaneous span and Simultaneous proportion values for monolingual children across gender. For simultaneous span scores, the mean value obtained by monolingual males were 5.50 with a standard deviation of 0.50 and mean scores obtained by monolingual females were 5.50 with the standard deviation of 0.86. For simultaneous proportion scores, the mean value obtained by monolingual male were 0.93 with a standard deviation of 0.05 and mean scores obtained by monolingual females were 0.92 with the standard deviation of 0.072. As it is evident from the table, males and females had same mean values for simultaneous span score. However slight difference was noted for simultaneous proportion scores for males and females.

Table 2: Mean scores of Simultaneous span and Simultaneous proportion scores in Frog matrices test for monolingual group across the gender

Gender		Simultaneous span	Simultaneous proportion
Male	Mean	5.50	0.93
	SD	0.50	0.05
Female	Mean	5.50	0.92
	SD	0.86	0.07

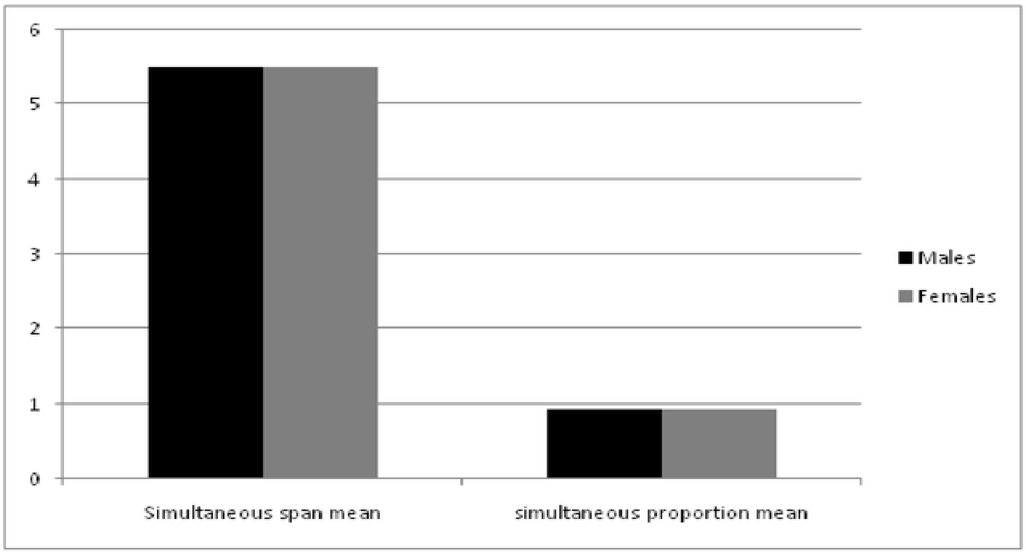

Figure 4: Mean scores of Simultaneous span and Simultaneous proportion scores in Frog matrices test for monolingual group across the gender.

The mean scores and standard deviation values are depicted in Table 3 and figure5 for sequential span and sequential proportion values of Frog matrices test for bilingual group across the gender. The mean values of sequential span scores in males and females were 5.63

and 5.56 with a standard deviation of 0.49 and 0.56 respectively. The mean values sequential proportion scores in males and females were 0.86 and 0.85 with a standard deviation of 0.04 and 0.05 respectively. Results indicated that males had better sequential span and sequential proportion scores compared to females.

Table 3: Mean scores and Standard Deviation of Sequential span and Sequential proportion scores in Frog matrices test for bilingual group across the gender

Gender		Sequential span	Sequential proportion
Male	Mean	5.63	0.86
	SD	0.49	0.04
Female	Mean	5.56	0.85
	SD	0.56	0.05

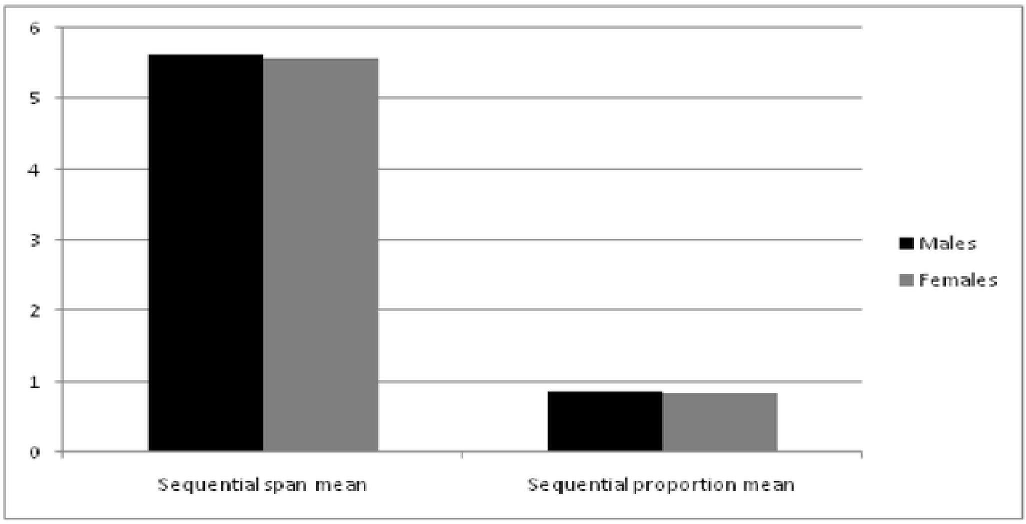

Figure 5: Mean scores of Sequential span and Sequential proportion values in Frog matrices test for Bilingual group across the gender

Table 4 and Figure 6 shows the mean scores and standard deviation of simultaneous span and simultaneous proportion scores in Frog matrices test for bilingual group across the gender. In simultaneous span scores the mean value obtained by males was 5.73 with a standard deviation of 0.44 and in females the mean value obtained was 5.73 with the standard deviation of 0.52. In simultaneous proportion scores the mean vales obtained by males was 0.96 with a standard deviation of 0.029 and in females the mean scores obtained was 0.97 with the standard deviation of 0.039. As it is evident in the table males and females had same mean values for simultaneous span score. However slight difference was noted for simultaneous proportion score for males and females.

Table 4: Mean scores of Simultaneous span and Simultaneous proportion scores in Frog matrices test for Bilingual group across the gender

Gender		Simultaneous span	Simultaneous proportion
Male	Mean	5.73	0.96
	SD	0.44	0.02
Female	Mean	5.73	0.97
	SD	0.52	0.03

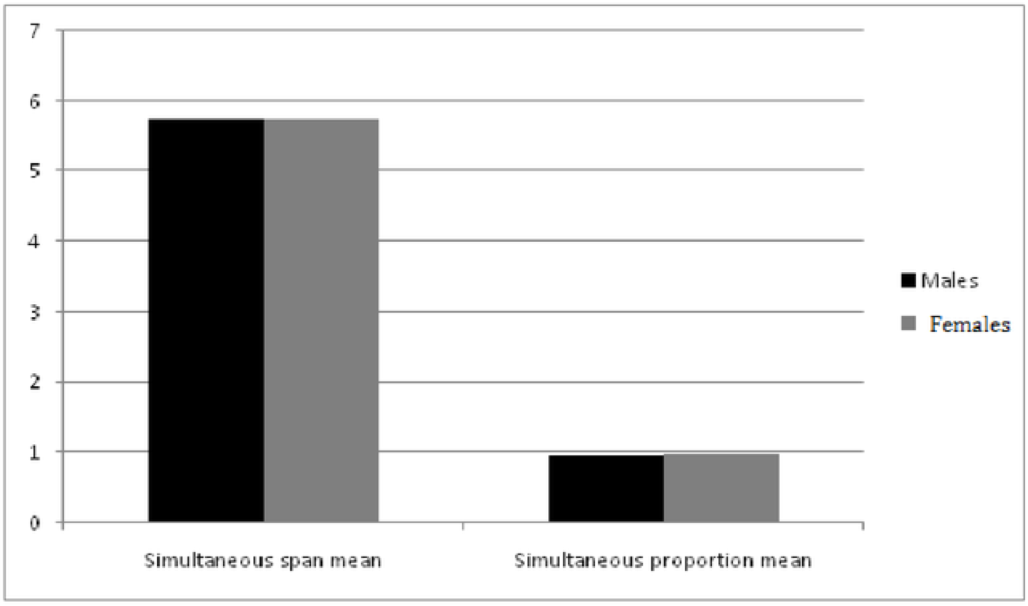

Figure 6: Mean scores of Simultaneous span and Simultaneous proportion scores in Frog matrices test for Bilingual group across the gender.

Multivariate tests were carried out to find the statistically significant difference in performance for visuospatial working memory task between groups (monolingual and bilingual), between the gender (males and females) and to find the interaction between the groups and gender.

Table 5: Results of Multivariate tests of visuospatial working memory task between genders.

BETWEEN GENDER df (1, 58)	F	Significance
Sequential span	2.64	0 .10
Sequential Proportion	2.05	0.15
Simultaneous span	0.00	1.00
Simultaneous proportion	0.78	0.78

From the table 5, it can be inferred that, that there was no significant difference between genders for visuospatial working memory for different scores which included simultaneous span, simultaneous proportion, sequential span and sequential proportion. Since there was no significant difference in performance between genders for visuospatial working memory, the data of both the genders were combined and multivariate tests were carried out to find the significant difference in performance between the groups (monolingual and bilingual).

The results of multivariate tests demonstrated a significant difference in the performance between monolingual and bilingual group for Sequential span scores ($F=21.24$, $p<0.05$), Sequential proportion scores ($F=42.19$, $p<0.05$), Simultaneous span scores ($F=4.43$, $p<0.05$) and Simultaneous proportion scores ($F=20.58$, $p<0.05$) of Frog matrices test.

Discussion

The purpose of this study was to compare the visuospatial working memory in Kannada monolingual and Kannada- Dakhni bilingual children in the age group of 9-9.11 years. The results of the current study indicated that bilinguals performed better compared to the monolinguals in visuospatial working memory task. These results are consistent with the results of previous studies carried out by Blom, Küntay, Messer, Verhagen, &Leseman (2014) where the bilingual children showed cognitive gains in visuospatial working memory tests. The results of the study can also be supported by the findings of Blom, Küntay, Messer, Verhagen, &Leseman (2014) which reported bilingual advantages that emerged most consistently for the Dot Matrix test. Present study also showed that in both simultaneous and sequential presentation condition bilingual group performed better compared to monolingual group. However Morales, Calvo & Bialystok (2013) in studying the development of visuospatial working memory using frog matrices in monolingual and bilingual children observed better performance in the simultaneous condition than in the sequential condition.

Findings of the present study showed that visuo-spatial working memory was enhanced in bilingual group. The activity of speaking two or more languages on a daily basis is an experience that may produce changes in cognitive performance. The process by which bilingualism prompts this experience incited cognitive change is likely in light of the need to monitor attention to the target language in the context of joint enactment of the other language.

Conclusion

The study compared visuo spatial working memory skills between mono and bilingual children. The study found that bilinguals perform better than monolinguals on two different conditions of visuo spatial working memory skills. Therefore based on the results of the study it can be hypothesized that bilingual children may exhibit advantage for in visuo spatial working memory skills when compared to children who speak one language.

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Tables

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	SD	0.76	0.05
Female	*Mean*	4.87	0.76
	SD	0.82	0.10

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Male	*Mean*	5.73	0.96
	Std. Deviation	0.44	0.029
Female	*Mean*	5.73	0.97
	Std. Deviation	0.52	0.039

Table 5: Results of Multivariate tests of visuospatial working memory task between genders.

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