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Original article

Reading Comprehension of Sentences in Kannada-English Bilingual Individuals with Aphasia

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ABSTRACT

The present study aimed at exploring the sentence comprehension proficiency in Kannada-English bilingual individuals with aphasia in L1 and L2 using accuracy and reaction time measures. 20 Kannada-English bilingual individuals with aphasia followed by CVA in the age range of 26 to 75 years participated in the study. Western Aphasia Battery – Kannada was used to diagnose the type of aphasia and measurement of aphasia quotient. International Second Language Proficiency Rating Scale (ISLPR) was used to assess proficiency in the two languages. A total of 50 correct sentences, 50 semantically violated and 50 syntactically violated sentences in each language were presented randomly using DMDX software. All the subjects were asked to read the sentences and judge whether the sentence was correct in meaning and form and press the appropriate response keys. Accuracy and reaction time were measured for all three types of sentences in each language and statistical analysis was done. Results of both accuracy and reaction time measurements revealed significant deficits in sentence comprehension in Kannada as well as English. Mean accuracy scores were better and longer reaction times were seen in Kannada than in English although they were statistically not significant. The results are discussed in terms of variables affecting the sentence comprehension in individuals with aphasia such as proficiency levels, age of second language acquisition and exposure/usage levels.

KEYWORDS: Accuracy and reaction time measures, Bilingual aphasia, Language processing in bilingual aphasia, Reading comprehension of sentences, Syntactic and semantic processing.

INTRODUCTION

Individuals with aphasia do exhibit deficits in several language domains such as auditory comprehension, naming, fluency, reading and writing. Individuals with aphasia always have difficulty in comprehending both spoken and written sentences. Several studies have been carried out in the past to examine the language deficits in aphasia at word and sentence level in auditory mode [1, 2, 3, 4]. However, individuals with aphasia have also been found to be slow besides exhibiting difficulties in reading comprehension at sentence level. Reading comprehension is a complex phenomenon in which semantic, syntactic, and orthographical factors are integrated to accomplish the task.

Sentence comprehension is a multifaceted process which requires quick and accurate access to the lexical system to retrieve and understand the semantic and syntactic information provided by the sentence. Thus, the speed of lexical activation or accuracy of lexical information (or lack of it) may contribute to the sentence comprehension impairments in individuals with aphasia [5]. Few of the speech language therapy techniques designed to improve language skills in individuals with aphasia have used reading comprehension as one of the major strategy thus making them as important as other language skills.

India is one of the largest bi and multilingual country in the world. The percentage of bilingual population in India is increasing due to globalization, education. Similarly, there is a rise in bilingual individuals with communication disorders including aphasia. Differences were observed in language deficits between monolinguals and bilinguals indicating that the language deficits in monolinguals cannot be generalized to bilinguals. Several domains of language such as naming, comprehension, fluency, etc were studied in both monolinguals and bilinguals extensively in both western and Indian contexts.

Few studies have been carried out in the western context to understand the reading sentence comprehension in individuals with aphasia, studies are lacking on reading comprehension in individuals with bilingual aphasia. Among the available studies, majority of them have used

only accuracy measures to explore the reading comprehension deficits. However, speed of processing of reading comprehension in individuals with bilingual aphasia is needed to be studied to understand whether deficits are at higher language level or at processing level. More research is also needed to understand how different languages (native and second) are processed after brain damage in these individuals. Thus the present study was carried out with the aim of exploring the reading comprehension deficits in individuals with bilingual aphasia using reaction time and accuracy measurements in both native and second languages.

MATERIALS AND METHODS

Participants: participants were 20 Kannada – English bilingual persons with aphasia (PWA) with mean age of 55.8 years. All the participants were assessed using Western Aphasia Battery-Kannada [6] to assess the type of aphasia. The participants had completed graduation from universities with 15 years of education. All the participants were native Kannada (L1) speakers and were exposed to English (L2) language since the age of five years. These participants had English as their medium of instruction throughout the education beginning at three years of age till graduate level. Language proficiency levels in English (L2) were measured using International Second Language Rating Scale [7] (ISLPR). The demographic details of participants along with results of the language evaluation and proficiency levels are given in Table 1.

Table 1. Demographic details and proficiency level ratings of PWA.

Participant	Age/Gender	Site of lesion	Type of aphasia	WAB AQ	Proficiency rating in English (L2) – ISLPR (premorbid)				Months post onset	Education
					S	L	R	W		
APH01	65/M	Left MCA CVA	Broca's	26	4	4	4	4	22	BA
APH02	57/M	Left MCA CVA extending to Insula	Broca's	46.8	4	4	4	4	16	B.Sc
APH03	35/M	Left MCA territory	Broca's	56.3	5	5	5	5	9	B.E
APH04	46/M	Left subcortical CVA	Broca's	65.2	4	5	5	5	12	BA
APH05	67/M	Left MCA/ACA CVA	Broca's	37.9	3	4	4	4	16	M.Sc
APH06	62/M	Left MCA CVA	Broca's	62.3	4	4	4	4	20	M.Sc
APH07	51/M	Acute left MCA/PCA territory infarct	Broca's	65.9	5	5	5	5	17	B.Sc
APH08	72/M	Left fronto-temporal area infarct	Broca's	38.6	4	5	4	4	10	B.Sc
APH09	56/M	Left MCA territory infarct	Broca's	49.3	4	4	4	4	15	BE
APH10	45/M	Left MCA CVA	Broca's	54.8	5	5	5	5	10	MA
APH11	62/M	Left MCA CVA	Broca's	69.3	4	4	4	4	22	M.Sc
APH12	66/M	Left MCA CVA	Broca's	44.8	4	4	5	4	13	B.Ed
APH13	53/M	Left frontoparietal infarct	Anomic	75.5	4	5	4	4	9	M.Com
APH14	37/M	Large CVA over left	Broca's	29	5	5	5	4	7	M.Sc

		hemisphere								
APH15	40/M	Left MCA infarct	Broca's	65.6	4	4	4	4	16	B.Tech
APH16	56/M	Left MCA CVA (inferior division)	Broca's	66.7	5	5	5	5	22	B.Sc
APH17	70/M	Left MCA infarct	Broca's	37.8	3	4	4	4	20	B.Sc
APH18	58/M	Left fronto-temporal including insula	Broca's	40.3	4	4	4	4	15	B.E
APH19	60/M	Left inferior frontal gyrus infarct	Broca's	56.7	4	4	4	4	12	B.Com
APH20	58/M	Left MCA CVA	Broca's	55.2	5	4	5	5	9	M.A

Materials: a total of 150 sentences with a mean length of utterance (MLU) of 3–5 words in each language were used in the present study. Of these, 50 were semantically and syntactically correct sentences, 50 were semantically violated and 50 were syntactically violated sentences. Syntactic violations in the stimuli were formed by altering the tense structures, person-number-gender (PNG) markers, singular/plural errors and phrase structure violations. Semantic violations were formed by changing the semantic category, meaning of the sentence. These sentences were transformed into picture formats with a resolution of 900*600 pixels. Test stimuli were loaded into HP Compaq V6425TU laptop and the sentences were presented randomly through DMDX software.

Procedure: the participants were asked to fill in the consent form and were tested for language proficiency in both Kannada and English. The test stimuli were presented to subjects on a laptop screen through DMDX software. Each stimulus was displayed in the centre of the screen until the subject pressed the response button or for the duration of 30000 milliseconds, whichever was earlier. 2000 milliseconds after a key was pressed, the next stimulus appeared on the screen. The whole session lasted for the duration of two hours. In the semantic judgment task, subjects were instructed to read sentences and press the right shift key if the sentence was semantically correct and press the left shift key if the sentence was semantically incorrect. In the grammaticality judgment task, the participants were instructed to read and press the right shift key if the sentence was syntactically correct and press the left shift key if the sentence was syntactically incorrect. The participants were instructed to respond accurately as quickly as possible.

RESULTS

The accuracy and reaction time data were analyzed using SPSS v20 software within and across languages and type of sentences.

Accuracy measures

Table 2 presents the mean accuracy data as a function of language and type of sentences. Two-way repeated measures ANOVA was carried out to analyze the main effect of the type of sentence in each language. ANOVA results indicated that there was a main effect of the type of sentence [$F(2, 38) = 181.84$, $p<0.05$] and language [$F(1, 19) = 27.229$, $p<0.05$]. Results also revealed a significant interaction between language and type of sentence [$F(2, 38) = 9.574$, $p<0.05$].

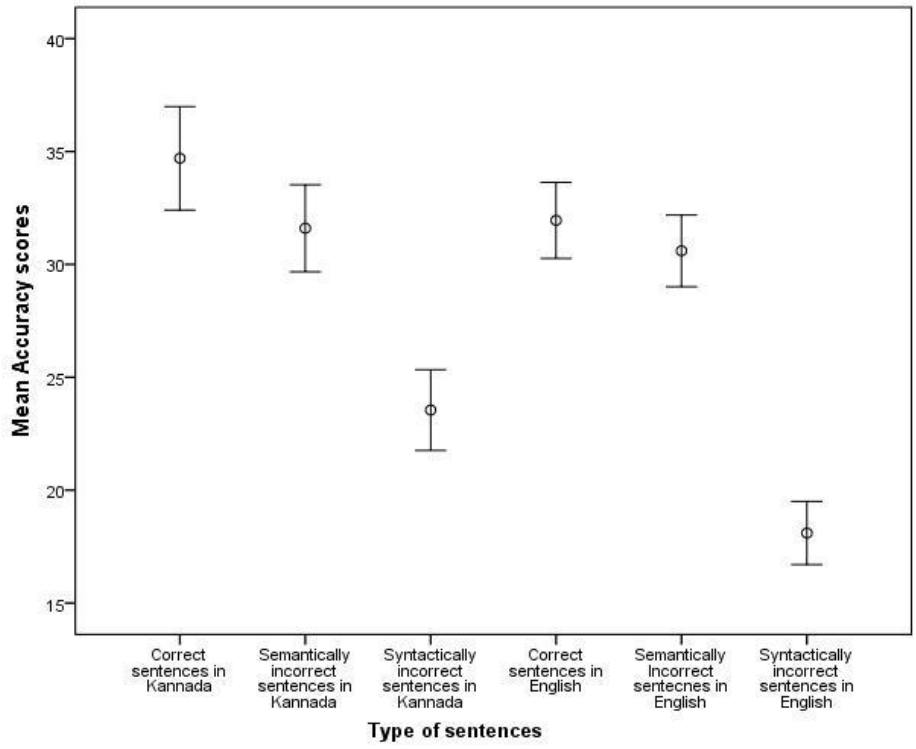
Table 2. Mean number of accurate responses for three types of sentences across L1 and L2.

Type of sentences	**Language**	**Mean**	**S.D.**	**Percentage of accurate responses (%)**	**Paired samples t-test**		
					Df	***t-value***	***p***
Correct	Kannada	34.7	6.90	69	19	3.955	< 0.01*
	English	31.95	7.60	63.9			
Semantically violated	Kannada	31.6	5.12	63.2	19	1.209	> 0.05
	English	30.6	7.62	61.2			
Syntactically violated	Kannada	23.55	5.81	47.1	19	5.687	< 0.01*
	English	18.1	4.98	36.2			

One-way ANOVA was conducted in each language to analyze the main effect of type of sentence. ANOVA results indicated that there was a main effect of type of sentence in accuracy data of three types of sentences in Kannada [F (2, 38) = 84.920, p<0.05]. In Kannada, participants made more errors in the syntactic judgment task (M=23.5) than in the semantic judgment task (M=31.6). Pair-wise comparison revealed significant differences between judgment of correct and semantically violated sentences at 0.05 significance levels and also between correct sentences and syntactically violated sentences at 0.05 significance levels on accuracy measures indicating a significant effect of semantic and syntactic violations.

In English, one-way ANOVA results indicated that there was a main effect of the type of sentences in accuracy data [F (2, 38) = 161.34, p<0.05]. In English language too, participants made more errors in syntactic judgment task (M=18.1) than semantic judgment task (M=30.6). In comparison to judgment of correct sentences (M=31.95), participants performed poorly on syntactic judgment tasks (M=18.1). However, pair-wise comparisons revealed no significant difference between judgment of correct and syntactically violated sentences at 0.05 significance level. On the other hand, pair-wise comparisons revealed a significant difference between correct sentences and semantically violated sentences at 0.05 significance level on accuracy measures in L2. The overall percentage of scores for all three types of sentences was higher in L1 than in L2 on accuracy measures. Figure 1 illustrates this difference.

Figure 1: Error-bar graph showing mean and SD differences across two languages for three types of sentences on accuracy measurements.



Paired samples t test results revealed a significant difference in performance between Kannada and English for correct sentences and syntactically violated sentences. However, no significant difference was found between Kannada and English languages for semantically violated sentences (Table 2).

Reaction Time (RT) measures

Reaction times of accurate responses across three types of sentences in each language were coded and analyzed. Thus, in Kannada, only RTs of 694 correct sentences, RTs of 632 semantically violated sentences and RTs of 471 syntactically violated sentences of 1000 responses were considered for statistical analysis.

In English, RTs of 639 correct sentences, RTs of 612 semantically violated sentences and RTs of 362 syntactically violated sentences were considered for further statistical analysis.

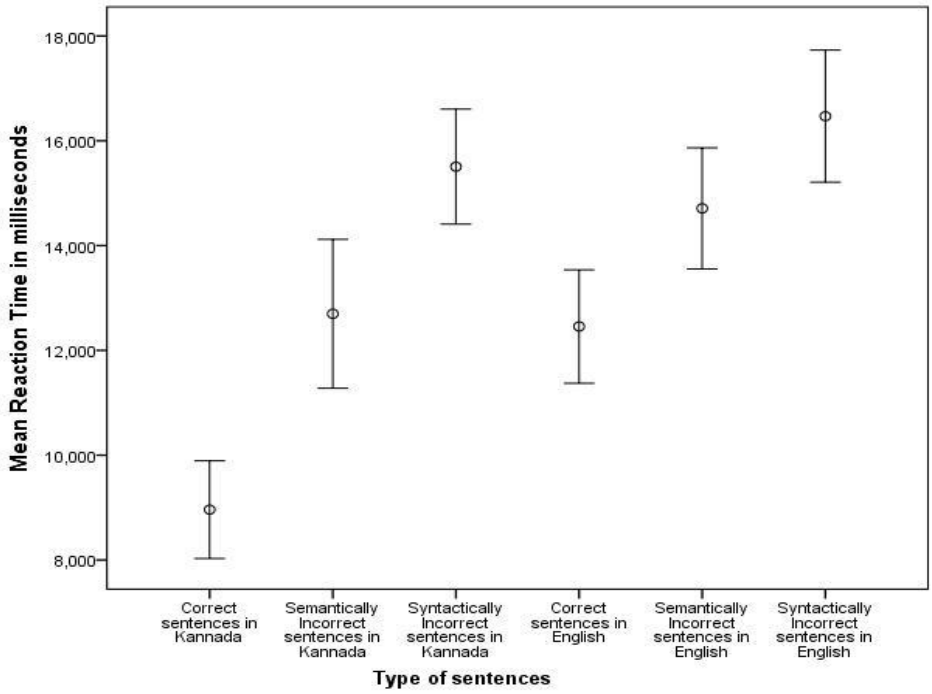
Table 3: Mean RTs (in milliseconds) for three types of sentences across L1 and L2.

Type of sentences	Language	Mean RT (in milliseconds)	S.D. (in milliseconds)	Paired samples t-test		
				Df	*t-value*	*p*
Correct	Kannada	8960.60	1990.21	19	-8.178	< 0.01*
	English	12456.37	2312.95			
Semantically violated	Kannada	12697.95	3034.80	19	-2.648	< 0.05*
	English	14710.17	2469.08			
Syntactically violated	Kannada	15505.98	2343.27	19	-1.586	> 0.05
	English	16469.12	2692.28			

Table 3 presents the mean reaction time data as a function of language and type of sentences. Two-way repeated measures ANOVA was carried out to analyze the main effect of the type of sentence in each language over the speed of processing. ANOVA results indicated main effect of the type of sentence [F (2, 38) = 67.569, p<0.05], and language [F (1, 19) = 23.986, p<0.05]. Results also revealed that there was a significant interaction between language and the type of sentence [F (2, 38) = 5.922, p<0.05]. One-way ANOVA was conducted in each language to analyze the main effect of type of sentence on reaction time measures. ANOVA results indicated main effect of the type of sentence in reaction time data of three types of sentences in Kannada [F (2, 38) = 65.654, p<0.05]. Pair-wise comparisons revealed significant differences in reaction times of all three types of sentences.

Figure 2 illustrates the graphical representation of the mean and S.D. of reaction time for each type of sentence.

Figure 2: Error-bar graph showing mean and SD differences across two languages for three types of sentences for reaction time measurements (in ms).



In English, one-way ANOVA results indicated main effect of the type of sentence in reaction time data [F (2, 38) = 22.483, p<0.05]. Pair-wise comparisons revealed no significant difference between judgment of correct and semantically violated sentences. On the other hand, pair-wise comparisons revealed a significant difference between RTs of semantically violated sentences and syntactically violated sentences in L2. Figure 2 illustrates this difference. Paired sample t test results revealed a significant difference in reaction times between Kannada and English for correct sentences and semantically violated sentences. However, no significant difference was found between reaction times in Kannada and English languages for syntactically violated sentences (Table 3).

DISCUSSION

The present study was aimed at exploring the sentence comprehension deficits in Kannada-English bilingual individuals with aphasia on accuracy and speed of processing measures. The results were analyzed to find out the differences in processing of sentences in L1 and L2 in individuals with aphasia. Two-way ANOVA results of accuracy measures revealed significant main effect of type of sentence, and language and interaction effect between language and sentence type indicating differences in processing of correct, semantically violated and syntactically violated sentences in L1 and L2 in bilingual individuals with aphasia. One-way ANOVA results in Kannada and English revealed significant differences in processing three types of sentences with poor comprehension of sentences with syntactic errors. The deficits in both L1 and L2 indicated that the sentence comprehension deficits are due to abnormal functioning of central linguistic processes caused by CVA. Paired samples t-test was done to compare the performance of individuals with aphasia on Kannada and English revealed significant differences between L1 and L2 on comprehension of correct and syntactically violated sentences, whereas no significant differences were found on comprehension of semantically violated sentences.

Two-way ANOVA results of reaction time data revealed significant main effect of type of sentence, language and interaction effect between language and sentence type. The mean reaction time in English for all three types of sentences is longer than that of Kannada indicating faster processing of sentences in L1 than in L2. However, paired samples t-test results indicated significant differences in speed of processing in L1 and L2 for only correct and semantically violated sentences but not on syntactically violated sentences. The results of the present study also revealed that sentence comprehension is much slower in aphasics than typical bilingual individuals. These results were also similar to the results of studies carried out by Caplan *et al* [1] and Grodzinsky [2] in auditory sentence comprehension in individuals with aphasia indicating no effect of modality of presentation of stimuli.

The speed of lexical activation is found to be one of the main factors contributing to the impaired sentence comprehension in persons with aphasia [1, 4, 5] (PWA). It is also found that PWA exhibit incomplete access to word class information and are slow in integrating the words of sentence [1, 8]. DeDe [5] conducted a study to explore the effect of factors like word frequency and modality of stimulus presentation on sentence comprehension in aphasia. Results indicated that similar to typical individuals [11, 12], the individuals with aphasia have exhibited difficulty in comprehending sentences with low frequency words than that of high frequency words, the extent being greater however. DeDe [13, in press] have also studied the performance of PWA on reading and auditory comprehension of sentences with subject and object clefts to explore the functioning of central linguistic processes. The author found that the individuals with aphasia exhibited more errors in sentences with object cleft than subject cleft in both auditory and reading modalities. Reaction time data analysis revealed that the individuals with aphasia showed longer response times for the verb segment in sentences in both modalities. These results concluded that the sentence comprehension impairments are similar in both auditory and reading modalities, suggesting sentence comprehension impairments more at central linguistics processes than that of modality specific deficits.

Peach, *et al.* [14] studied comprehension of sentences in individuals with anomic and conduction aphasia using picture-pointing auditory and reading comprehension tests. Results revealed that both groups performed better on comprehension tasks. The authors also found a moderate level of correlation for responses in auditory and visual modalities for anomic group and a strong correlation observed for conduction aphasia group indicating good relation between auditory and reading comprehension. Studies on reading comprehension in aphasia have also revealed influence of contextual factors like preceding and following components of sentence [15]. Duman, *et al.* [16] carried out a study on auditory sentence comprehension in Turkish individuals with Broca's aphasia to explore the effects of word order and case. Results revealed that the individuals with aphasia comprehended sentences better when both word order and case information was provided suggesting presence of integration deficits during syntactic comprehension in individuals with aphasia.

Reading comprehension of sentences is a multifaceted process in which subjects are required to integrate information related to semantic, syntactic and orthographic information. The deficits at central linguistic processes in aphasia are found to be affecting processing of both lexical items and sentences. The present study also found that speed of lexical activation as one of the main factor contributing to the impaired sentence comprehension in individuals with aphasia which is supported by the previous studies of Del Toro [8]; and Thomson & Choy [5]. The results of the present study also support the results of studies by DeDe [13, in press] who reported longer reaction times for processing of verb segments during sentence comprehension.

The high proficiency and high exposure/usage levels in L2 are may be the contributing factors for similar performance in L1 and L2 on accuracy and reaction time measures. The incomplete access to word class information and delay in integrating words of a sentence in individuals with aphasia may lead to the longer times for processing and comprehension of sentences. However, further research is required to explore the effects of reading context and processing of different types of semantic and syntactic violations in individuals with aphasia to gain insights into the language processing in greater depth. Further, studies are also required to understand the differences in processing of sentences in various modalities using accuracy and reaction time measures that will help in understanding of the deficits at central linguistic level processes in individuals with aphasia.

CONCLUSION

The Indian bilingualism and multilingualism is different to that of western context due to changes in education system, professional system and variations in exposure/usage levels. Hence, the results of the studies in western context may not be directly applicable to Indian context and require more in depth studies on sentence processing in individuals with aphasia on accuracy and reaction time measures. The effect of similar (within Indian languages) and distinct features of Indian languages compared to that of English also need to be explored in future studies.

The present study revealed that although the overall sentence comprehension is impaired in individuals with aphasia, the performance in L1 is better than in L2 in individuals with aphasia during reading comprehension of sentences on both accuracy and speed of processing. The effect of other variables such as usage, proficiency levels, and age of second language acquisition, modality specific deficits in bilingual individuals with aphasia needs to be explored in future.

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