

Cognitive Psychology and Bilingualism

Rupashree Brahma Kumari*, Anamitra Basu

School of Humanities Social Sciences and Management, IIT Bhubaneswar, Bhubaneswar, 751007, India

Abstract Cognitive psychology explores the internal mental process of human beings. The present paper is aimed at identifying the association between language and cognitive process of the human brain. It is found that using two languages in regular life is not only beneficial to various cognitive developments but also helps in communicating with the contemporary world. This paper also deals with the processing of language in bilinguals and monolinguals. Several experimental or behavioural paradigms have been used and discussed in measuring language process of bilinguals like Dichotic Listening Test, Tachistoscopic Test and Stroop Test. The behavioural paradigms reveal not only the language process of bilinguals and monolinguals but also identify who performs better in cognitive skills. The current paper particularly focuses on examining the benefits of bilingualism, discuss the behavioural paradigms and its applications.

Keywords Cognitive Psychology, Bilingualism, Behavioural Paradigm, Benefits of Bilingualism

1. Introduction

Cognitive psychology is a dynamic field which scientifically investigates the internal mental process of the human brain such as memory, perception of language, communication, emotion, and attention. Cognitive psychology was first introduced by an American psychologist named Ulric Neisser in his book "Cognitive Psychology". Neisser has defined, "*Cognitive psychology refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used*"[80]. Language is an essential function of human cognition. It is associated with mental activities such as thinking about ideas and dealing with emotions and feelings. Various languages are found around the world and the users are categorised according to their uses of languages. Bilingualism has been used by psychologists, neurologists, and modern linguists and used in educational programs as it is the best way to educate all types of children in the contemporary world[45] This paper also examines how bilingualism influences cognitive as well as linguistic performances of bilinguals and monolinguals.

2. Language

Language is regarded as "The jewel in the crown of cognition"[86]. According to Riegler & Riegler, language is defined "as a set of symbols and principles for the combination of those symbols that allows for communication and

comprehension"[92]. It shapes our thought and the thought process is connected with language. Total number of languages are spoken around the world is 6000-7000[103], and most of the people can speak two or more languages.

2.1. Bilingualism

Bilinguals refer to individuals who use two languages in their everyday life[52]. Second language users come under this category. Many studies have proved that bilinguals are smarter than monolinguals in relation to insight problem solving task,[77, 29, 85]. Monolingualism has been introduced by Romaine in his book *Bilingualism*[93]. People who have knowledge of, and use only one language are known as monolinguals or unilinguals. The native language users come under this category[39].

2.2. Multilingualism

Multilingualism is a global phenomenon in the current world. It relates to different fields of studies, namely anthropology, linguistics, psychology and neuroscience[31]. Multilingualism operates in different ways of perceiving the surrounding world, enhancing thought process and ideas[42]. A study on multilingualism not only contributes to social factors but also to learning pattern of adults and children[82]. People who have knowledge of and use more than two languages come under this category. Being multilingual is beneficial in personal and social life, and helpful in higher order problem solving capacity[82].

3. Language and Human Brain

3.1. Language Centre in Human Brain

Human brain is divided into four major areas. The *Frontal Lobe* is associated with the motor function, memory,

* Corresponding author:

rupashree.psy@gmail.com (Rupashree Brahma Kumari)

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planning, reasoning, impulse control, judgment and the area of speech known as *Broca's area* for language production. *Parietal Lobe* is responsible for somatosensory processing of human brain. The *Occipital Lobe* is related with the visual processing. Lastly, the *Temporal Lobe* is responsible for auditory processing and *Wernicke's area* where the sound images are stored.

Broca's area and Wernicke's area: Paul Broca (1864) found that left frontal lobe of the brain is responsible for speech and it was named as Broca's area. Carl Wernicke (1875) had found that left temporal lobe, located at posterior part of the auditory cortex is responsible for language understanding and is known as Wernicke's area [72, 97].

3.2. Hemispheric Involvements in Language

Structurally human brain is divided into two hemispheres namely the right hemisphere (RH) and the left hemisphere (LH) and they are structurally and functionally different [72]. Hemispheric lesion deficit researches have been proved that LH is concerned with language, mainly grammar and phonology i.e., speech sound where as RH is associated with the emotional properties of non-verbal stimuli [79].

4. Classification of Monolingualism and Bilingualism

The following criteria have been used to access the behavioural paradigms. Researchers have classified them as monolingualism, bilingualism and subtypes of bilingualism [61].

Monolinguals - a person having knowledge and understanding of one language through reading, writing and speaking.

Bilinguals - a person having knowledge and understanding of at least two languages with the capability of reading, writing and speaking.

Early Bilinguals- Two languages when acquired by the bilinguals earlier than the age of 6 years and hence, both languages of bilinguals are considered L1.

Late Bilinguals- Two languages when acquired by the bilinguals later than the age of 6 years is considered as late bilinguals.

Proficient Bilingual- When bilinguals' language performances on standard language proficiency exam exceeds 85% accuracy; they are rated as high proficiency.

Non-proficient Bilingual - When the bilinguals do not have the above criteria for proficiency of language, they are categorised under non-proficient.

4.1. Benefits of Bilingualism

Bilingualism is an integral part of our society and knowledge of two languages helps an individual's overall achievement in the modern world. It turns the human being smarter, intelligent, and has a powerful effect that helps to improve cognitive skills [29]. A ample numbers of studies have

concluded that bilinguals are proficient in diverse problem solving activities, and are intelligent, possess creativity, and are cognitively flexible than monolinguals. In early 1962, it is marked that the performances of bilinguals are superior to monolinguals on both verbal and nonverbal intelligence tasks [84]. Furthermore studies have concluded that bilinguals have more metalinguistic understanding [9, 10, 13, 34, 35, 43, 50, 54, 64, 90, 102] along with greater conceptual analysis and figurative presentation of skills [3, 5, 7, 24, 34, 51, 68 78]. A study was conducted on hemispheric specialisation among monolinguals and fluent French - English bilingual adults for speeded rhyme and syntactic category matching. The study concluded that, late bilinguals performed better than early bilinguals and monolinguals [10 6]. Besides bilinguals also have superior capacity in analysing problems and solving skills because they have greater ability to perceive significant information by ignoring non significant information [4, 11, 12, 15, 38, 99]. In addition, bilinguals have greater creativity, innovative thinking ability, and cognitive pliability [19, 58, 73, 90, 98, 54, 63, 75, 76]. In a recent research it was found that bilingual adults have more fluency and flexibility than monolinguals [69].

Bilinguals have more divergent thinking in solving insight problems than monolinguals. In this study the numbers of subjects who participated were classified as, monolinguals - 102, bilinguals- 64 and the following tasks were used - three insights and three non-insights problems. The result found that monolinguals were good at solving the non-insight problems than their own task of insight problems and late bilinguals identified similar performance in these two problems whereas early bilinguals show opposite result that gives advantage in solving insight problems than non-insight problems. The study illustrated that early bilinguals performed better in insight problem solving task than monolinguals. Apart from cognitive advantage of bilingual children, academic and social benefits were also observed, which is the effect of functioning and using of two languages in their everyday life. One can communicate with the persons who would not able to communicate with other society due to the barrier of language. Bilingualism also acts as a mediator when interpretation of other language is done [66].

4.2. Difficulties of Bilingualism

Previously it is believed that bilingualism had negative impact on developing minds, as a consequence the learning of two languages may creating confusion [53]. Research on adult bilinguals and children have manifest that bilingual children are weaker in verbal skills than monolingual groups. For example, in a picture naming task bilinguals are slower than monolingual groups [17, 27, 46, 57, 47, 91]. The bilinguals' also have slower in comprehending and articulating words, though the words are presented in L1 [89, 65]. Another study pointed out that bilinguals were not strong in their L2 than L1 when using arithmetic digit in word format both (L1 and L2) [44].

Recent study have analysed the effect of bilingualism on letter and category fluency tasks were measured in primary school children. The participants were selected from three cities of Iran, such as Persian monolinguals of Tehran, Turkish–Persian bilinguals of Tabriz, and Kurdish–Persian bilinguals of Sanandaj. The study concluded that bilinguals have both advantage, disadvantage and dissociative effect. Thus the degree of language proficiency of bilinguals is a necessary factor during the measurement of language[71].

5. Behavioural Paradigms of Study

Laterality studies can be done using different paradigms namely dichotic listening technique, dichaptic technique and split visual field technique.

In dichaptic test: Tactual sensations are measured by selectively presenting the subjects with stimuli contralaterally [69].

Split visual field technique: The visual field is divided into left and right so as to measure the hemispheric bias. In split visual field technique, the visual objects are projected laterally. When the objects are presented to the left visual field (LVF), the visual data is transmitted to the RH and when the stimuli are presented to the right visual field (RVF), the visual data is transmitted to the LH. In this technique, the visual field is virtually divided into left and right as if the brain is also divided[72].

Dichotic Listening Technique: In dichotic listening technique when the auditory stimuli are played simultaneously in both ears it reaches both hemispheres through ipsilateral and contralateral pathways[72]. This technique is used to evaluate the accuracy of word recognition through right and left ears. Whereas in visual test the pictures are projected for a short time then the accuracy of correct responses and interval duration are measured.

6. Studies

The study of bilingualism was conducted in the early 1970s, both experimentally and clinically[2, 104, 106]. Basically, earlier studies through the use of dichotic listening paradigm have concluded that the LH is dominant for speech and language[20, 21, 70, 101]. In addition, further studies have been conducted on language laterality in Native American children. Both studies have been administered with dichotic consonant-vowel task. Results concluded that Navajo children are more accurate in identifying left ear stimuli, which refers to the fact the Navajo has greater RH mediation of language, while the Anglo children were more accurate in identifying right ear stimuli, that refers to the greater LH mediation of language[63]. In a visual test, laterality dissimilarity for word identification in bilinguals was examined. The study concluded that LH advantage was observed for processing of both Spanish and English, irrespective of which language was learnt first[110].

Behavioural, neurological and imaging studies have significant role in language process[6]. Researches from variety of areas also proposed that RH is dominant for language processing. Similarly, other studies have documented that RH is relatively more involved in language processing[67]. Current studies have proved that RH is involved in language comprehension[28]. Another study on bilinguals has marked a slower language processing than monolinguals not only in second language L2 but also in first language L1[32, 48]. In clinical evidences researchers have mentioned that both languages of bilinguals are served by the LH in the same area of the monolinguals whereas experimental studies have reported no significant difference in lateralisation between bilinguals and monolinguals[83]. A further study revealed that LH is superior for verbal functions whereas RH is superior for visuospatial abilities configuration based face processing[56].

A study was conducted to assess the differential processing efficiency of the cerebral hemispheres in right and left-handed adults by using behavioural laterality tasks with linguistic stimuli. They concluded that, the LH is superior in the task, whereas RH was more involved in reading process[109]. Further study examined the role of RH in the comprehension of speech. The numbers of participants were 78. The result of this experiment showed that, RH supports in comprehension of speech and deals with the intention of the speaker[59]. To investigate the differences between RH and LH a cross modality study (auditory and visual) was conducted, using message-level sentences. 32 right-handed participants used computer based lexical decision task to record reaction time and errors. The result revealed that RH is dominant for message level information in sentences[49]. Recent study showed that emotional words (positive and negative) are processed faster than neutral words[74].

In a study sixty five behavioural studies were compared, with 24 monolingual groups and 51 bilingual groups. The variables of the experimental paradigms are coded as; dichotic listening (DL), visual preferences (V), age of L2 acquisition (early and late) and level of L2 proficiency (proficient and non-proficient). The study concluded that late bilinguals and monolinguals are LH dominant in language tasks regardless of the proficiency[61].

A recent meta-analysis has examined the behavioural laterality studies of the bilinguals and monolinguals. They concluded that early bilinguals have bilateral involvement for both languages, where as monolinguals and late bilinguals have LH dominance for both languages[62]. By using concurrent activities paradigm, a study was conducted on language lateralisation task and the study concluded that, LH superiority is observed in both groups. The total numbers of participants were- 32. Sixteen male bilinguals (Portuguese - English) between ages 20-35 years with a mean of 24.2 years participated; their first language was Portuguese and they first came in contact with English after the age of 12. Similarly other sixteen male monolinguals (English) who

participated in this study were between 20-24 years with a mean age of 21.3 years[95]. All participants were strong right handers, as determined by a short questionnaire[22, 81]. The bilingual subjects, who had taken part in the study, were selected for equal and high fluency in Portuguese and English. Their fluency was examined by a questionnaire in which the subjects rated their fluency in reading, writing, speaking and understanding of Portuguese and English. The participants in this study were adult-right handed males (Portuguese- English bilinguals and English speaking monolinguals). The task includes two experiments. In experiment-1, the words of bilinguals of both languages were presented in a mixed blocks. In experiment-2, the words were presented in a separate block. The result also showed that LH is dominance for both groups' bilingual and monolinguals[95]. Furthermore, a study on Portuguese - English bilinguals and a group of English monolinguals with concurrent activity and time task paradigm was conducted and the result revealed that there were no lateralisation differences among bilinguals and monolinguals[96].

In further study researchers have examined the preferences for English words among native Hebrew speakers by using visual studies. They concluded that LVF superiority was observed in the early bilingual group and the RVF superiority was present in the late bilingual group. The study showed that there is a RH relevant for the early stage of language acquisition[94]. Whereas late bilinguals marked no visual field differences and early bilinguals marked LVF superiority, in semantic task[105]. In addition research on normal adults reported that the RVF advantage is less for concrete words. The findings suggested that concrete words are more prevalent to the RH[23].

A study was conducted on Kannada-English bilingual adults with concrete nouns by using tachistoscopic study. The stimuli were presented bilaterally and the result concluded that subjects responded more words correctly in LVF[8]. A similar study was conducted on abstract and concrete nouns in Kannada with monolingual Kannada adults, with the help of tachistoscopic test. The result revealed that no visual field differences were found in concrete and abstract nouns[88]. Further study on monolingual Kannada children and bilingual Kannada - English children were conducted with a tachistoscopic technique to investigate the hemispheric superiority of either Kannada or English by using concrete nouns from both the languages. Ten monolinguals and bilinguals each were selected who were studying Kannada and English. The subject's mother tongue was Kannada. Bilingual groups were examined for their fluency, comprehension and expression in the second language English. All participants were right handed. After comparing the monolinguals' and bilinguals' performances in the study, the result revealed better performance by monolinguals than bilinguals in first language Kannada. The researcher also found the superiority of LVF compared to the RVF in both monolinguals and bilinguals[25].

Another study concluded that language differences and script differences may depend on the two hemispheric differences[55]. A laterality study on the orthographic (writing and spelling system of language) cue with French-English bilinguals was conducted. For this study sixteen French-English late bilinguals performed a speeded language recognition task on lateralised words that were either marked or unmarked. When the words were presented in the LVF, the response latency was faster to orthographically marked than unmarked words, particularly in second language English. In addition, L2 marked words were responded to, faster than L1 marked words. The study suggested that RH is associated with orthographic cues in recognition of language[108]. A recent study was conducted by using fMRI (Functional Magnetic Resonance Imaging) to identify primary factors that deal with semantic and orthographic processing of bilinguals in Chinese-English bilinguals. The researchers used both tasks, such as Chinese characters (L1) and English words (L2). They concluded that L2 (English) is more responsible for activation for RH than native language (Chinese)[36].

Bilinguals are capable of managing and controlling attention than monolinguals. Research on bilingualism [12, 14, 16, 41] have concluded that, bilingual peers are more prone to attentional control than monolinguals, while performing non verbal and linguistic tasks. The stroop paradigm has been used by many researchers[87]. The paradigm mainly deals with measuring the cognitive control mechanism of bilinguals and monolinguals. It is mainly concerned with attention[100]. Another study insight that bilinguals' language acquisition status was also responsible for the language lateralisation. The study divides bilinguals as, early bilingual, late bilingual, and monolingual but the researcher tested only late Chinese-English bilinguals with stroop paradigm. The study concluded that LH is dominant for Chinese character processing[85].

Recent research show dissimilar result in semantic processing mechanism due to different language processing of L1 and L2, for e.g. non-literal language or figurative language[37]. Another also study supported that LH produced the activation of both L1 and L2 where as RH is related with the non-literal or figurative language processing of L1 and literal accessible of L2[26]. In a hemispheric lateralisation study of Mandarin tone, four groups were tested (Native Mandarin listeners, English-Mandarin bilinguals, Norwegian listeners having experience with Norwegian tone and American listeners having no tone experience) by using dichotic technique to examine or identify which tone they have heard in both ears. They noticed that there is no ear advantage observed in Norwegian or American listeners. They also concluded that LH is dominant for native and proficient bilingual listeners (Mandarin tone) and no lateralisation was found for the non-native listeners, in spite of acquaintance with lexical tone[111].

Another study also mentioned that RH is more dominant

for language processing of L2 than L1[1]. Similarly other studies also cited the greater involvement of RH than LH during the processing of language[40]. Furthermore, recent advanced studies such as neuroimaging, Positron-emission Tomography (PET) and functional MRI have reported the dominance of RH in processing of language[33, 18]. Generally it is found that LH is more relevant in understanding and creating verbal language of human brain. Recent study has examined the effect of similarity between languages on hemispheric differences in bilinguals' brains. This study tested two groups such as, German native speaker (L1) with English as L2 and Italian native speaker (L1) with English as L2. The level of association of LH and RH was measured during language processing both groups with L2. The study examined by dichotic paradigm with words of L1 and L2. The result concluded that LH is dominant in number of responses for both languages and both groups. Moreover the LH was more relevant for processing of English language in German group[30].

7. Discussion

Both the languages (L1 and L2) of bilinguals are not separate, but they co-exist and rely on a common underlying proficiency (CUP). This characteristic will be beneficial for the proficiency in the first language (L1) as well as second language (L2) for bilinguals[45]. Numbers of studies have concluded that cognitive psychology not only reveals the cognitive flexibility of bilinguals in comparison to monolinguals but also language processing of bilinguals and monolinguals[16, 57, 73, 90, 98, 53, 63, 75, 76]. Thus this may be responsible for variation of results among bilinguals and monolinguals.

Other studies have mentioned that during processing of language bilinguals are slower than monolinguals in L1 and L2[32, 48]. Another study mentioned that monolinguals are better performed than bilinguals in L1[22]. These above studies reveal that the age of language acquisition (L1 and L2) may lead to different results among bilinguals and monolinguals. In a study it is found that RH is associated with orthographic cues in recognition of language[108, 36]. This may occur due to the particular writing system or style (script) of the language, leads to the different hemispheric involvement of both groups.

Furthermore studies have discussed on the superiority of LVF and RVF regarding the language processing among bilinguals and monolinguals[94, 96, 25]. In addition many evidences on hemispheric involvement on processing of language have showed that some have greater level of language dominance which is observed in LH where as others mentioned dominance of RH among both groups (bilinguals and monolinguals)[66,28,60 ,49,61,96].

On the other hand, studies have also mentioned that there are no lateralisation differences found among bilinguals and monolinguals[83]. Similarly, another study cited that there is no visual field differences were observed among bilinguals

and monolinguals[88], which may be attributed to the extraneous variables, such as age, gender, language proficiency, and handedness. Hence these studies have committed inaccuracy in statistical analysis. In a stroop paradigm, it is proved that the characteristics of bilinguals such as early bilinguals or late bilinguals are also related to language processing of bilinguals[85].

8. Conclusions

However by reviewing many evidences in bilingualism and monolingualism, it can be concluded that there are no clear concepts or evidences on hemispheric dominance for language in bilinguals and monolinguals. It is suggested that more researches could be conducted to clarify the hemispheric superiority in LH and RH among bilinguals and monolinguals in language processing.

The current paper also concludes that bilingualism has a significant benefit in cognitive, social and academic areas in comparison to monolinguals. This suggests that future studies should identify the usefulness of these advantages in different fields. Besides, future studies should clarify the characteristics of the participants such as age, gender and language proficiency. Lastly, behavioural paradigms have manifested mixed results on bilingualism and monolingualism.

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