# Cognitive Control in Bilingual and Multilingual Children

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**ALL INDIA INSTITUTE OF SPEECH AND HEARING**

**MANASAGANGOTHRI, MYSORE-570006**

**May 2012**

## CERTIFICATE

This is to certify that this dissertation entitled **"Cognitive Control in Bilingual and Multilingual Children"** is a bonafide work in part fulfillment of the degree of Master of Science (Speech-Language Pathology) of the student (Registration No. 10SLP004). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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# DECLARATION

This dissertation entitled **"Cognitive Control in Bilingual and Multilingual Children"** is the result of my own study under the guidance of Dr. K.C. Shyamala, Professor and HOD, Department of Speech-Language Pathology, All India Institute of Speech and Hearing, Mysore, and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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May, 2012

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***Guru sakshath parabrahma, thasmaishree guruve namaha".***

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*remembering how to fly"*

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# CHAPTER 1

# INTRODUCTION

Cognitive control refers to the ability to flexibly allocate mental resources to guide thoughts and actions in light of internal goals (Solomon, Ozonoff, Cummings, and Carter, 2008). A  Bilingual is one who can easily make use of two languages as a means of communication and also switch from one language to another whenever necessary (Oskar, 1971). Multilingualism has been defined as “the presence and use of two or more languages within a modern nation state” (Asher & Simpson, 1994). When there is a presence of two languages in mind there is a change in the fundamental aspects of language processing. Switching between representational systems and avoiding interference are processes which are routinely handled by the general executive control system. It has been demonstrated that bilingualism exerts systematic effects on cognitive performance.

Cognition is affected by the process of learning one or more languages. Children who have the ability to communicate in two languages i.e., bilingual children are different from monolingual children in many ways. The differences are evident in the way they acquire language, age of acquisition, proficiency in the language etc. Literature says that bilingualism is associated with more effective cognitive processing than monolingualism. Peal and Lambert (1962) suggested that there are no detrimental effects of bilingualism and there may even be some cognitive advantages. The assumption is that the constant management of two competing languages enhances “executive functions”, a reflection of better cognitive control. The most consistent empirical finding about cognition of bilingual children is their advantage in selective attention and inhibition (Bialystok, 2001).

Cognitive control involves processing of task-relevant information over competing information. Cognitive control is less required to perform simple or automatic behaviours, but must be engaged to a greater extent to guide action in novel, difficult or rapidly changing conditions (Braver et al., 2002; Bunge et al., 2002). Several studies have examined the development of cognitive and/or executive control in typically developing children and young adults. In typical development, more strategic and complex aspects of cognitive control continue to develop well into adolescence. For example, task switching involving inhibition (Davidson et al., 2006) and distraction related error rates (Crone et al., 2004) may not reach adult levels until late adolescence or early adulthood.

The assumption is that the constant management of two competing languages enhances "executive functions", a reflection of better cognitive control. The most consistent empirical finding about cognition of bilingual children is their advantage in selective attention and inhibition (Bialystok, 2001). In the Indian context, a study by Stephen, Sindhupriya, Mathur. and Swapna (2009) evaluated the cognitive linguistic performance in bilingual and monolingual children. The results revealed that bilingual children performed superior to the monolingual children on cognitive linguistic tasks including attention/discrimination, memory, problem solving and precocious cognitive development (Bialystok, 2001; Bialystok, Craik, Klein and Viswanathan, 2004; Bialystok, Craik and Ryan, 2006).

On the contrary, research reveals that monolinguals outperform bilinguals in tasks involving lexical access. Gollan and Colleagues (2002, 2005) report of deficits in naming and category fluency tasks in bilinguals. In addition to less efficient lexical retrieval, research has consistently found that bilinguals have smaller vocabularies in each language than comparable monolinguals (reviews in Bialystok, 2001; Oller & Eilers, 2002 Bialystok 2010). There is increased demand on the executive control for letter fluency tasks than category fluency. Due to which literature reveals that bilingual children surpass monolingual children on the letter fluency task (Kormi-Nouri et al., 2010). Lexical access also requires a certain amount of cognitive control in inhibiting the competing lexical neighbours. This implies that cognitive control is expressed differently in terms of the outcomes across tasks.

Research done in inhibitory tasks in bilingual children reveal that there is a continuous need to inhibit the nonused language generalized to more effective inhibition of nonverbal information (Bialystok and Martin 2004). This helps in forming a link between the inhibition of the nonverbal information (Simon task) and the inhibition of the unused language by using the lexical access task like naming or category fluency. (Bull and Scerif 2000) reported that inhibitory control serves as the individual child's mathematical ability.

The working memory system is generally considered to be an aspect of executive functioning in which information must be sustained in memory while manipulations are performed on that information in conformity to some rule or goal. Working memory is_important for early acquisition of literacy and numeracy skills (Blair & Razza, 2007 ;Gathercole et al., 2004, 2005; Savage et al., 2006) and also later language and math achievement (Gathercole et al., 2004; Passolunghi et al., 2007; Swanson & Kim, 2007). However, working memory performance in monolinguals and bilinguals is reported to be equivocal (Bialystok, 2008).

Bilingualism and multilingualism, in recent times, has largely become the rule and not the exception due to the global expansion. With increasing globalization, however, multilinguals are becoming more prevalent. Many children grow up speaking a minority language in their home, learn a second language at school, then a third language (or fourth or fifth, etc.) to conduct business or travel abroad. In India however this has always been the case due to the vast history and cultural differences. Census India (2001) reports that 19.44 percent are bilinguals and 7.22 percent are trilinguals. The evidence on whether multilingualism leads to even greater benefits than bilingualism is scant. It may be speculated that the extent to which cognitive control is mandated for a multilingual would be greater than that for a bilingual. Kave, Eyal, Shorek, Cohen-Mansfield., (2008) reported significantly higher maintenance of cognitive status in older age in trilinguals than in bilinguals and even greater maintenance by multilinguals. This gives rise to the question as to whether the knowledge of more than two languages lead to better cognitive control than just knowing two languages?

## NEED FOR THE STUDY

There is a dearth of studies in Indian context in terms of the cognitive control in children. There has been evidence to say that there is better cognitive control in bilinguals than in monolinguals. Whether this implies that children having knowledge of more than two languages have greater cognitive linguistic benefits than the bilinguals is yet to be conclusively reported. India being a multilingual country it is important to explore a multilingual advantage over a bilingual one.

Studies have considered tasks such as category fluency, letter fluency, Simon task, working memory etc., individually to investigate cognitive control. However, there is a dearth of investigations that have considered the entire gamut of cognitive control inclusive of executive function and lexical access tasks. The present study offers the scope for the same.

## AIM OF THE STUDY

To investigate the cognitive control in bilingual and multilingual children.

## OBJECTIVES OF THE STUDY

To investigate executive functions in bilingual and multilingual children by using Simon task.

- To explore the functioning of working memory in bilingual and multilingual children by using picture location subtest of Children's Memory scale (Morris & Cohen, 1997).
- To examine the lexical access in bilingual and multilingual children by using picture naming, category fluency and letter fluency tasks in both languages (Kannada and English).

# CHAPTER 2

# REVIEW OF LITERATURE

*To have another language is to possess a second soul.*

*- Charlemagne (742/7 - 814), King of the Franks*

The present study aimed to investigate the cognitive control in bilingual and multilingual children. The recent interest in the relation between bilingual language processing and non-linguistic cognitive control abilities has been supported by research showing that bilinguals outperform monolinguals on tasks involving executive functions. Bilingualism and multilingualism, in recent times, has largely become the rule and not the exception due to the global expansion. The evidence on whether multilingualism leads to even greater benefits than bilingualism is to be investigated. India being one of the largest of multilingual countries it becomes important to explore whether there is multilingual advantage over a bilingual one.

## 2.1 Bilingualism and cognitive development

Studies seeking evidence for bilingual effects on development began with the conservative assumption that any detectable effect of a linguistic experience would be found in the domain of linguistic competence. Thus, during the 1970s and 1980s, investigators explored the development of metalinguistic awareness in monolingual and bilingual children. The bilingual advantage in judging sentences has less to do with metalinguistic knowledge than with an attentional advantage in selectivity and inhibition. These processes are signature components of executive functioning (Bialystok, 1988; Cromdal, 1999).

Several studies have examined the development of cognitive and/or executive control in typically developing children. In typical development, more strategic and complex aspects of cognitive control continue to develop well into adolescence. For example, task switching involving inhibition (Davidson et al., 2006) and distraction related error rates (Crone et al., 2004) may not reach adult levels until late adolescence or early adulthood. Karmiloff-Smith (1992) points to representational redescription as the fundamental cognitive change for children. Zelazo & Frye (1997) describe cognitive complexity as the mechanism for cognitive development. Both of these perspectives describe a process similar to the role that analysis of representation structures plays in building up mental representations.

There are studies reported in the literature that bilingualism has a positive effect on children's cognitive development (e.g., Bialystok, 1999; Kormi-Nouri, Moniri & Nilsson, 2003; Oren, 1981). Their findings support the bilingual advantage hypothesis, which postulates that bilingual children have extensive practical experience of two languages at an early age and become more able than their monolingual counterparts to focus on parts of a body of information and inhibit other parts. There is also a suggestion that bilingual advantages depend on the complexity of tasks and level of cognitive demands (Bialystok, 2001, 2004, 2005).

## 2.2 Cognitive control and bilingualism

Control refers to the level of attention and inhibition recruited during cognitive processing. These mechanisms of attention regulate the access to activation of mental representations that are involved in performing various tasks. Cognitive control can also be defined as the ability to flexibly allocate mental resources to guide thoughts and actions in light of internal goals (Solomon M, Ozonoff S, Cummings, and Carter

C., 2008). It involves processing of task-relevant information over competing information. Cognitive control is less required to perform simple or automatic behaviours, but is essentially employed to a greater extent to guide action in novel, difficult or rapidly changing conditions (Braver et al., 2002; Bunge et al., 2002).

Research by Bialystok has shown that bilingual children develop control processes more readily than do monolingual children but that the two groups progress at the same rate in the development of representational processes (Bialystok, 1993, 2001).The development of the executive-function system is located in the prefrontal cortex and is the most crucial cognitive achievement in early childhood.

Children gradually master the ability to control attention, inhibit distraction, monitor sets of stimuli, expand working memory, and shift between tasks. Importantly, these are the same cognitive processes that show the first evidence of decline in aging. Therefore, if bilingualism affects executive functioning, the impact should be found across the entire cognitive system and throughout the entire lifespan. There seems to be a strong link between cognitive control and bilingualism reported in the literature.

Early bilinguals have to constantly control interfering information from the two active and competing language systems which might train and enhance their cognitive control abilities (Martin-Rhee and Bialystok, 2008). Bilingualism has a taxing influence on inhibitory control which requires speakers to suppress one language when using another. Bilingualism has been shown to accelerate the development of executive control in children (Bialystok, 2001; Carlson & Meltzoff, 2008) using nonverbal control tasks such as the flanker task (Mezzacappa, 2004; Yang, Shih, & Lust, 2005), perceptual analysis (Bialystok & Shapero, 2005), and rule switching (Bialystok & Martin, 2004).

It is evident, therefore, that experience has a powerful effect on cognitive performance and brain organization and structure. Is bilingualism/multilingualism one such experience that leads to these general cognitive outcomes? The central aspect of the bilingual experience that may be responsible for generalized effects on cognitive performance comes from the well-documented observation that for fluent bilinguals who use both languages regularly, both languages are active and available when one of them is being used (Hernandez, Bates and Avila, 1996; Dijkstra, Grainger and VanHeuven, 1999; Marian, Spivey and Hirsch, 2003; Sumiya and Healy, 2004; Rodriguez-Fornells et al., 2005; Chee, 2006; Crinion et al., 2006; Kroll, Bobb and Wodniecka, 2006; Kaushanskaya and Marian, 2007).

This situation creates a problem of attentional control that is unique to bilinguals where there is a need to correctly select a form that meets all the linguistic criteria for form and meaning but is also part of the target language and not the competing system. The need to control attention to the target system in the context of an activated and competing system is the single feature that makes bilingual speech production most different from that of monolinguals and is at the same time responsible for both the cognitive and linguistic consequences of bilingualism.

Some tasks that have been found to be largely sensitive towards processes involved in cognitive control are simple recognition and working memory (Luciana et al., 2005), inhibitory processes as assessed by a stop-signal task or a Simon task (Williams et al., 1999; Bialystok 2009), and simple switch costs on a single-trial counting Stroop Task. The cognitive control as observed during these tasks appears to reach adult levels by approximately age 12 ( Cepeda et al., 2001).

## 2.3 Tasks involving Executive control

Executive functions are the processes responsible for attention, selection, inhibition, shifting and flexibility that are at the centre of all higher thought. Simon task in one particular task which assesses the inhibitory control. This also helps in investigating processes involved with attention and executive function. (Lu and Proctor,1995). In a routine Simon task, the coloured stimuli are presented on the left or the right of the screen, which results in a key press. The result of pressing the key on the same side as the colour is associated to a congruent trial; when the correct key and stimulus position conflict, the trial is incongruent.

Results from Bialystok et al., (2004) studies reveal that monolinguals have a larger Simon effect (the difference between the incongruent and the congruent trials) than the bilinguals. Bialystok, Craik, Klein, and Viswanathan (2004) evaluated groups of younger and older adults who were monolingual or bilingual on an adaptation of the Simon task. When the colored squares are presented centrally, there is no conflict between the position of the stimulus and side of the appropriate response. Monolinguals and bilinguals did not show any differences in reaction time; however older participants took longer to respond. The colored squares, when appeared laterally, Simon effects were found to be larger for older monolinguals. Simon effect is the difference between the incongruent and the congruent trials. This study reports that the bilingual advantage was especially strong in older adults, suggesting that bilingualism may afford some protection against at least some forms of cognitive aging.

Children's development of inhibitory control is well documented (Diamond, 2002, for review) and is a central feature of many theories of cognitive development (e.g., Dempster, 1992; Tipper, 1992; Harnishfeger and Bjorklund, 1993;

Diamond and Taylor, 1996). Research done in inhibitory tasks in bilingual children reveal that there is a continuous need to inhibit the unused language generalized to more effective inhibition of nonverbal information (Bialystok and Martin 2004). This helps in forming a link between the inhibition of the nonverbal information (Simon task) and the inhibition of the nonused language by using the lexical access task like naming or category fluency. Bull and Scerif (2000) reported that inhibitory control serves as the individual child's mathematical ability.

### 2.4 Tasks involving working memory

The working memory system is generally considered to be an aspect of executive functioning in which information must be sustained in memory while manipulations are performed on that information in conformity to some rule or goal. Working Memory is essential for the skilled self-regulation of learning and memory. It is dynamic and active as it focuses on newly presented information and helps integrate previously stored information. (Baddeley, 1986).

Baddeley and Hitch (1976) viewed working memory as a unitary system with a phonological or visual-spatial storage unit, an articulatory loop for maintaining information in the temporary storage unit and the central executive. With advances in research methodologies, this early view was revised substantially. Importance was given to the redirection of focus of the storage unit to the multiple components in working memory, integration of those components with each other and long term memory and structural relationships among the components.

Recent working memory model (Baddeley, 2002) facilitates other kinds of storage, including an episodic buffer for storing novel stimuli. Originally, the articulatory loop, was hypothesized to maintain information in temporary phonological stores through speech rehearsal. It has been renamed the *phonological loop* and is currently thought to coordinate integration of different codes in the episodic buffer and guide the learning of new words through overt naming. (Refer figure2.1)

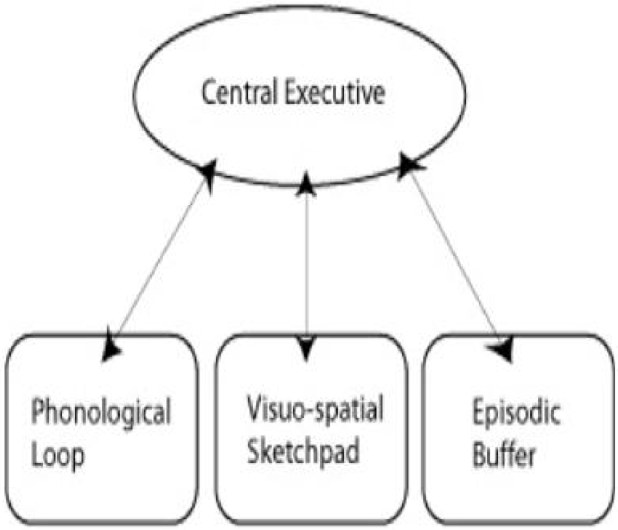


*Figure 2.1.* Representation of the Baddeley's working memory model (Baddeley,2002).

Working memory is important for early acquisition of literacy and numeracy skills (Blair & Razza, 2007 ;Gathercole et al., 2004, 2005; Savage et al., 2006) and also later language and math achievement (Gathercole et al., 2004; Passolunghi et al., 2007; Swanson & Kim, 2007). Efficiency of working memory is related to 1) executive functions that manage the component operations singly and in coordination with each other. Its overall efficiency is influenced by the temporal coordination of the multiple processes in the working memory (Fuster 1997). 2) inhibition (Gunter, Wagner & Friederici, 2003). 3) processing speed of the various components of working memory (Ribaupierre, 2002).

Working memory plays a crucial role in executive processing (Miyake & Shah, 1999). There have been researches done to show that bilinguals have a greater working memory than monolinguals. The need to manage two languages gives the bilinguals better working memory abilities (Micheal and Gollan, 2005). In contrast to this there are also reports of working memory performance being equivocal in monolinguals and bilinguals (Bialystok, 2008).

Bialystok, E., Craik, F. & Luk, G. (2008) correlated the effect of bilingualism on working memory. Nonverbal working memory was tapped to avoid confounding evidences in verbal disadvantage in bilinguals. 96 participants participated in the study, out of which 24 young and old monolinguals (mean age 20.7 years and 67.2 years respectively) and 24 young and old bilinguals (mean age 19.7 and 68.3 years). The working memory performance was measured across the participants using forward and backward corsi block. Self ordered pointing task was also employed. Monolinguals and bilinguals performed equivalently on the working memory task. Therefore the question of whether bilingualism affects working memory performance remains open.

## 2.5 Lexical Access models and Bilingualism

Current models of lexical access in bilingual speakers typically assume that the semantic system is shared by the two languages of a bilingual (De Bot, 1992; Costa, Miozzo & Caramazza, 1999; Green, 1986; 1998; Kroll and Stewart, 1994; Poulisse & Bongaerts, 1994). Each semantic/conceptual representation is connected to its corresponding lexical nodes in the two languages. Although, some researchers (Lucy, 1992; Paivio & Desrochers, 1980; Van Hell & De Groot, 1998, have claimed that conceptual representations are language dependent, there are proposals which widely favor the idea that, at least for common words, bilingual subjects have a unique conceptual store shared by both languages. Some researchers argue for the existence of a switching device that turns the flow of activation from the semantic system on and off, preventing the activation of lexical nodes that do not belong to the language-in-use (McNamara & Kushnir, 1972; McNamara, Krauthammer, Bolgar, 1968; Penfield and Roberts, 1959). This suggests that the bilingual speaker would have only one lexicon activated at a time.

However, there are other theories reported which assume that the activation of the semantic system spreads to the two languages of a bilingual regardless of the language programmed for response (De Bot, 1992; Green, 1986; Poulisse & Bongaerts, 1994; Poulisse, 1997). According to these theories, there is parallel activation of the two languages of a bilingual regardless of the language chosen for production. In other words, current models follow the general spreading activation principle and assume that there is parallel activation of the two lexicons of a bilingual.

The spreading activation principle assumes that multiple lexical nodes are activated and, therefore, a lexical selection mechanism is required in order to select the target lexical node. The lexical selection mechanism is assumed to consider the activation levels of all the lexical nodes and to pick the one with the highest level of activation. It is further assumed that the ease with which the selection takes place depends on the level of activation of both the target lexical node and the non-target lexical nodes, which act as lexical competitors and may hinder the selection of the target word.

Bilingual speakers are expected to select the lexical node corresponding to the intended concept, but also must do so in the appropriate language. Researchers explain this phenomenon suggesting the existence of an inhibitory mechanism that suppresses the activation of the lexical nodes of the language not-in-use (DeBot, 1992, Green, 1986, 1998; Poulisse & Bongaerts, 1994). According to this proposal, lexical selection is language non-specific since it considers the activation of all the lexical nodes in the bilingual's two languages. Hence, lexical access entails inhibitory mechanisms that are crucial for the proper selection of lexical nodes. According to the parallel activation principle, once the semantic representation of *dog* is activated it sends activation to its corresponding lexical nodes in the two lexicons of a bilingual (‘dog’ and ‘perro’). Here, at this level the lexical node which has highest activation is selected. (Refer Figure 2.1)

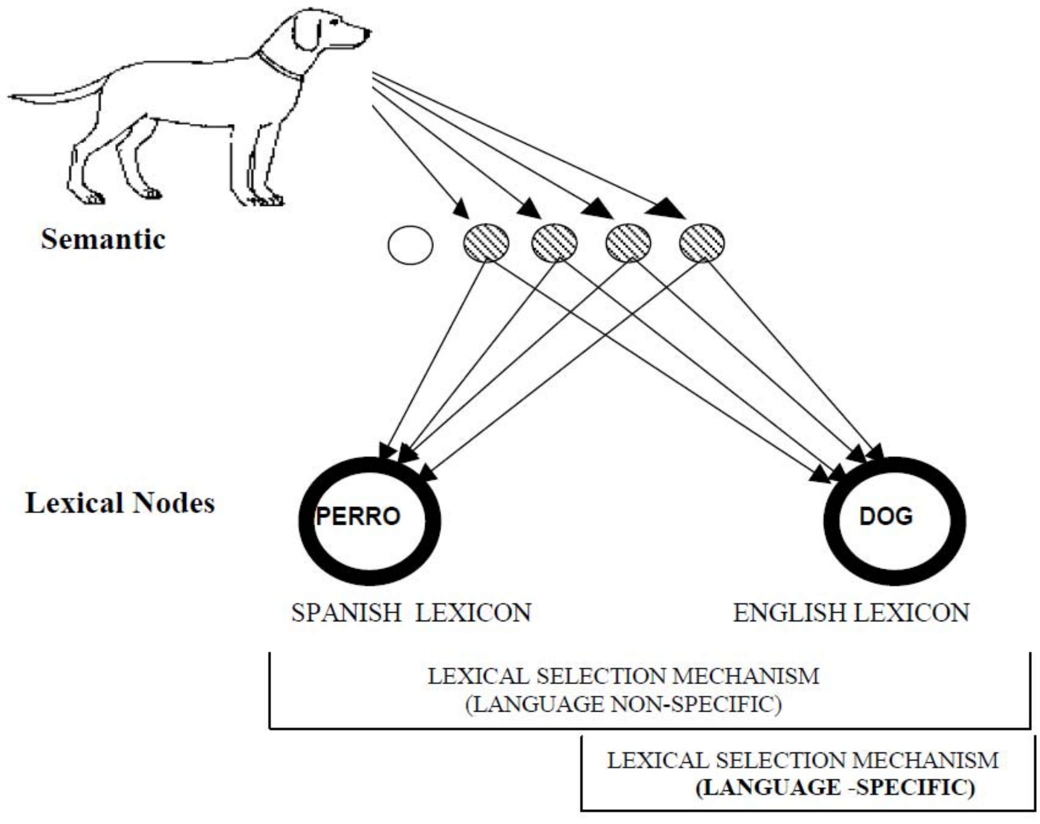


*Figure 2.2.* Schematic Representation of the language specific and language non-specific hypotheses in Bilinguals.

Contrary to this account there are also assumptions that the lexical selection mechanism considers only the activation of the lexical nodes of the language-in-use (Costa, et al, 1999; Costa & Caramazza, 1999; Roelofs, 1998). According to these models, the activation of the lexical nodes that do not belong to the language-in-use are not considered during the lexical selection process. Therefore, lexical selection may proceed in the same way as with monolingual speakers, since only one language is considered at any moment in time. This proposal assumes that lexical selection is language- specific since the activation of the lexical nodes of the language-not-in-use are ignored. Hence, with this background it would be interesting to explore how the mechanisms of lexical access are organized in the multilinguals.

## 2.6 Tasks involving Lexical Access

### *2.6.1 Picture Naming and bilingualism*

Research investigating linguistic performance has reported vocabulary deficits for fluently bilingual children (Oller & Eilers, 2002), increased frequency of tip-of-the-tongue states in adults (Gollan & Silverberg, 2001), longer naming times for bilingual adults (Gollan, Montoya, Fennema-Notestine, & Morris, 2005), more errors in picture naming (Roberts, Garcia, Desrochers, & Hernandez, 2002), reduced scores on letter and category fluency tests (Gollan, Montoya, & Werner, 2002; Rosselli et al., 2000), and poorer word identification through noise (Rogers, Lister, Febo, Besing, & Abrams, 2006). Although there is some debate about the underlying reason for the bilingual disadvantage in lexical retrieval, substantial agreement exists that there is parallel activation of both languages when bilinguals are using one of them (Beauvillain & Grainger, 1987; Brysbaert, Van Dyck, & Van de Poel, 1999; Colome´, 2001; Costa, 2005; Van Hell & Dijkstra, 2002).

Gollan, Fennema-Notestine, Montoya, and Jernigan (2007) found that naming difficulties for bilinguals persist into older age; however, unlike the research on the executive control advantages for bilinguals, it does not appear that the magnitude of the bilingual disadvantage on these linguistic skills changes with aging. Gollan and colleagues (2005) showed that Spanish– English bilinguals (many of whom stated that English was their stronger language) named pictures in English more slowly than English monolinguals, but participants in both groups classified the pictures as natural or human-made equally rapidly. Thus, the bilingual deficit does not appear to affect access to semantic information.

There are a few studies which have found no differences between monolingual and the bilingual group in cognitive and linguistic tasks (Rosenblum & Pinker, 1983). Toukomaa and Skutnabb-Kangas (1977), children with native competency in one language only, usually their mother tongue but with a much less command of the other language, showed neither positive nor negative cognitive effects i.e. their performance did not differ from that of monolingual children.

In spite of agreement that both languages are active and influence each other in bilingual speech, there are different explanations for how that cross-language interaction affects language production. Costa and colleagues accept that both languages are active (Costa, Roelstraete, & Hartsuiker, 2006) and that there is a benefit to cognitive control from language management in bilinguals (Costa et al., 2008) but reject the notion that the unwanted language is inhibited (Costa, Caramazza, & Sebastia´n-Galle´s, 2000). However, the role of inhibition of the unwanted language is supported in research by Meuter and Allport (1999) using a Stroop task and by Levy, McVeigh, Marful, and Anderson (2007) using retrieval-induced forgetting of a dominant language.

Gollan and colleagues also agree that both languages are active (Gollan et al., 2002; Gollan & Kroll, 2001) but argue for a connectionist architecture in which access to specific lexical items in each language is determined by connection strength (Gollan & Brown, 2006). For all these models, therefore, there is agreement that lexical access is more difficult for bilinguals and that both languages of the bilingual are active and interact during speech production in either language, creating the need for some type of attention or selection.

*2.6.2 Verbal Fluency and bilingualism*

Verbal fluency, most commonly used neuropsychological test, has been used in evaluating executive function and language in many research studies. In this task, participants are asked to generate as many words as possible that conform to a constraint given by an initial letter (e.g., “F”) or category membership (e.g., “animals”) during a fixed period of time (Strauss, Sherman & Spreen, 2006).

Estes (1974) pointed out that verbal fluency tasks present excellent information on how people organize their thinking. Also, he suggested that successful performance on such tasks depends somewhat on the subject’s ability to organize output in terms of clusters of meaningfully related words. Verbal fluency tasks provide useful information about the development of both word retrieval strategies and lexical-semantic networks during childhood (Sauzéon et al., 2004).

Several studies reveal that monolinguals outperform bilinguals in tasks involving lexical access. In a study by Gollan et al. 2000 bilinguals performed poorly compared to monolinguals in category and letter fluency tasks. They also revealed that bilingual disadvantage is less for semantic fluency than in letter fluency. Gollan et al. (2002) reported that bilinguals perform less well than monolinguals in both letter and category fluency tasks. They also found a significant interaction between the two, such that bilingual disadvantage was greater for semantic fluency than it was for letter fluency. They explained this interaction suggesting that interference between languages is likely to be greater for semantic fluency, where translation equivalents are category members, whereas for letter fluency, the translation equivalents would be rejected immediately because they do not begin with the same letter. Gollan and colleagues (2005, 2007) report of deficits in category fluency and naming tasks in bilinguals. In addition to less efficient lexical retrieval, research has consistently found that bilinguals have smaller vocabularies in each language than comparable monolinguals (Bialystok, 2001; Oller & Eilers, 2002 Bialystok 2010).

There has been a considerable amount of research on verbal fluency in bilinguals. Sandoval, T.C., Gollan, T.H., Ferreira, V.S., & Salmon, D.P. (2010) compared thirty bilinguals and thirty monolinguals with the objective of comparing verbal fluency between the two groups. The participants were given the task of verbal producing 15 semantic categories (e.g. type of clothing) and 24 double letter categories (e..g. words beginning with /fa/). The bilinguals produced fewer first responses and slower first response times. They suggested an analogy exists between bilingualism and dual-task effects (Rohrer et al., 1995.). This suggests a role between-language interference in explaining the bilingual fluency disadvantage, and implies that bilingual fluency will be maximized under testing conditions that minimize such interference.

Kormi-Nouri et al (2010) traced the influence of bilingualism on letter and category fluency tasks. Participants were 1,600 monolingual and bilingual children from three cities in Iran: Tehran (Persian monolinguals), Tabriz (Turkish–Persian bilinguals), and Sanandaj (Kurdish–Persian bilinguals). The participants were required to generate as many words within 3 minutes with nine Persian letters and thirty-one categories, which was presented separately. Bilingual children generated more words than monolingual children in the letter fluency task; this effect was more pronounced in Grade 1 and for Turkish–Persian bilinguals. However, Persian monolinguals generated significantly more words than both bilingual groups in the category fluency task. Thus, bilingualism can be of both advantage and disadvantage, and produce a dissociative effect.

Letter fluency tasks employ increased demand on executive control than category fluency, with literature support regarding the same (Korni-Nouri et. al 2010). The demands of category fluency are congruent with normal procedures for word retrieval in that the meaning is cued and words associated with that meaning are primed and available. Thus, when asked to generate names of fruits, the inherent associations among various fruits in semantic memory facilitate recall. In contrast, the letter fluency condition imposes an arbitrary criterion on word generation: Conversation does not normally require the generation of words by virtue of their initial letter. Moreover, the letter fluency task additionally imposes a set of restrictions that exclude repetitions of words in different forms and therefore requires more intensive monitoring and working memory.

In contrast, the letter fluency condition imposes an arbitrary criterion on word generation: Conversation does not normally require the generation of words by virtue of their initial letter. Moreover, the letter fluency task additionally imposes a set of restrictions that exclude repetitions of words in different forms and therefore requires more intensive monitoring and working memory. Thus, category fluency is strongly indicative of vocabulary size.

## 4.7 Studies in the Indian Population

Bilingualism and multilingualism, in recent times, has largely become the rule and not the exception due to the global expansion. In India however this has always been the case due to the vast history and cultural differences. Census India (2001) reports that 19.44 percent are bilinguals and 7.22 percent are trilinguals. The evidence on whether multilingualism leads to even greater benefits than bilingualism is scant.

Kave et al, (2008) reported significantly higher maintenance of cognitive status in older age in trilinguals than in bilinguals and even greater maintenance by multilinguals. Ring (2010) did a pilot study on 100 individuals belonging to three groups (30 monolinguals, 46 bilinguals and 24 multilinguals) to compare the reaction time measures on a task similar to Simon task called the Go/No-Go task across the three groups. The participants were in the age range of 18 to 27 years. Each participant took two online RT tests, one of which required attentional control. Results show a trend for multilinguals to be faster at the attentional control task.

There was a slight correlation between language ability and reaction times though not statistically significant.

In the Indian context a study was carried out in the by Rajasudhakar and Shyamala (2008) in bilingual adults and elderly. They studied two groups of subjects consisting of forty young and old individuals. Each group had 20 monolinguals and 20 bilinguals on whom Cognitive Linguistic Assessment Protocol (CLAP) - adults developed by Kamath and Prema (2003) in Kannada was used. Assessment of the cognitive-linguistic abilities of young as well as older monolinguals and bilinguals was done. The results indicated that bilingual adults and elderly performed better on all the domains of CLAP indicating a cognitive-linguistic advantage.

Cognitive linguistic abilities in bilingual children was investigated by Stephen, Sindhupriya, Mathur, & Swapna (2010). The participants were divided into 12 bilingual children and 12 monolingual children in the age range of 7-8 years. The Cognitive Linguistic Assessment Protocol for Children (CLAP-C) (Anuroopa & Shyamala, 2008) for children was administered on the selected participants. Attention/discrimination, memory and problem solving were the three domains assessed using CLAP. Bilingual children outperformed monolinguals in all the three sections of CLAP, in this study. The results of this study support the premise that bilingualism favors cognitive development

By and large, researchers in the past have provided evidences of cognitive processing and control in monolinguals and bilinguals. Evidences of cognitive control in multilinguals are scant and are largely inconclusive. This gives rise to the question as to whether the knowledge of more than two languages lead to better cognitive control than just knowing two languages in children

# CHAPTER 3

# METHOD

The aim of the current study was to explore the cognitive control in typically developing bilingual and multilingual children. This was carried through the measures obtained on tasks involving executive control and lexical access. The study was carried out in two phases.

## 3.1 Participants

Two groups were considered for the present study. They were as follows:-

**Group 1** included Kannada-English bilingual children (40 participants).

**Group 2** included Kannada, English and any other language (x) multilingual children (40participants).

In total eighty participants were included in the present study. A comparison of cognitive control was carried across and within the two groups through the measures obtained on the set of tasks. The participants in each group were divided into 4 subgroups (7-9years; 9-11years; 11-13years; 13-15years) of ten each.

### *3.1.1 Participants inclusion criteria*

1. The participants selected in both the groups (bi and multilingual) had to have a mean age of 7-15years.
2. They had to have vision and hearing acuity within normal limits respectively.
3. The participants had to have no history of neurological and/or psychological disorders and this was ensured using the 'WHO Ten questions disability screening checklist' (Singhi, Kumar, Malhi, and Kumar, 2007).

4. All the participants were rated for their proficiency in their second and third languages on the International Second Language Proficiency Rating Scale (ISLPR) (Wylie and Ingram, 2006).
5. The participants in the bilingual group had to have a transactional proficiency in the second language. In the multilingual group had to have a transactional proficiency in the second and third languages.
6. The participants were selected from various English medium schools in and around Mysore.

The participants in each group were divided into 4 subgroups (7-9years; 9-11years; 11-13years; 13-15years) of ten each.

## 3.2 Materials

A set of tools were used for the various tasks. They are tabulated in Table 3.1.

***Table 3.1***

*Tools used in the study and their purposes*

| S.No | Test/ Stimulus, Author | Purpose in the present study |
|---|---|---|
| 1. | WHO Ten questions disability screening checklist' (Singhi, Kumar, Malhi, and Kumar, 2007). | To rule out any history of neurological and psychological disorders in the children. |
| 2. | International Second Language Proficiency Rating Scale (ISLPR) (Wylie and Ingram, 2006). | ISLPR describes language performance at eight points along the continuum from zero to native like proficiency in each of the four macro skills (speaking, listening, reading and writing). In the present study only two macro skills speaking and listening were considered. |
| 3. | Simon Task (Simon,1969) | To evaluate the executive functions within and across the two groups. |
| 4. | Children's memory scale (CMS) (Morris & Cohen,1997) | Picture locations subtest of CMS was used to explore working memory within and across the two groups. |
| 5. | Boston Naming Test (BNT) (Chengappa & Sunil Kumar., 2010) | To evaluate lexical access in both Kannada and English in both the groups. |
| 6. | Category fluency | To evaluate lexical access in both Kannada and English in both the groups. |
| 7. | Letter Fluency | To evaluate lexical access in both Kannada and English in both the groups. |

## 3.3 Procedure

The tasks categorized under the following domains were administered to the two groups of participants in a quiet room with adequate lighting.

*3.3.1. Executive Control*

Executive control was tested by means of a Simon task. The experiment was presented on a laptop Dell Inspiron with a 15-inch monitor. The sequence of events and collection of data was controlled by a program running in DMDX (Foster & Foster,2003) The experiment began with a fixation cross (+) in the center of the screen, measuring x=0.48 degree, y=0.40 degree, that was visible for 800 milliseconds (ms) and will be followed by a 250 ms blank interval. A red or blue square appeared on the left or the right side of the screen at the end of this interval, and remained on the screen for 1000ms if there is no response.

**Instructions:** Participants were instructed to press letter ‘Z’ key when they see a blue square and the letter ‘M’ key when they see a red square as fast as possible. There was a 1000 ms blank interval before the onset of the next stimulus. The participants were given four practice trials at the start of the experiment. They had to complete all four trials correctly to proceed to the experimental trials. Twenty eight experimental trials were presented in a random order , half of which were presented with the square on the same side as the associated response key (congruent trials) and half of which were presented with the square on the opposite side (incongruent trials).

**Scoring:** The accuracy and reaction times of the participants were recorded.

*3.3.2 Working memory*

This was tested using the picture locations subtest of Children’s memory scale (Morris Cohen, 1997). The subtest consisted of 1-16 stimulus items. For ages 5-8 the items tested were 1-10, while for ages 9-16 the whole subtest was administered. In the picture location subtest, the participant was shown a stimulus page with pictures placed in various locations within a rectangle. The stimulus page was then removed from view, and the examinee was asked to place the response chips on the response grid in the same locations as the pictures appeared on the stimulus page. Recording was done using a record form grid.

**Scoring:** Each correct placement was given a score of one. For ages 5-8: The scores for items 1-10 were added. The score range was 0-30 points. For ages 9-16: the scores of items 1-16 were added. The score range was 0-72 points.

*3.3.3 Lexical Access*

All the tasks under lexical access were carried out both in Kannada and English. The tasks were first carried out in Kannada and then the tasks were then repeated in English after a span of fifteen days.

a) **Picture Naming:** Boston Naming Test (BNT) (Chengappa & Sunil Kumar., 2010) was administered in both the bilingual and multilingual group in Kannada and English. A set of fifty seven line drawings of objects were presented using DMDX software on a Dell Inspiron laptop 15 inch monitor. The stimulus appeared on the center of the screen and remained on the screen for 1000ms if there is no response. Randomized trial for picture naming task was followed after fifteen days to remove the effect of familiarity.

**Instructions and recording:** Participants were asked to name the objects seen on the screen as soon as possible. There was a 1000ms blank interval before the presentation of the next stimulus. The accuracy and reaction times of the participants were recorded.

b) **Category Fluency (animals and fruits):** At the start of the task, the participants were given two practice trials. For this task the participants were asked to name as many items as possible belonging to the respective taxonomic categories within one minute. The responses were audio recorded in a digital recorder. A score of one was given for every correct response. Responses like proper nouns, slang words and repetition of responses were omitted from scoring.

c) **Letter fluency task:** At the start of the task, the participants were given two practice trials. The participants were asked to say as many items starting with the letter F, within a minute in English. The same procedure was repeated for letters A and S. Similarly, for the letter fluency task in Kannada the following sounds from Cognitive Linguistic Assessment Protocol-A (CLAP-A) (Kamath, 2001) /p/, /s/ and /t/ were chosen. The responses were audio recorded using a digital recorder. A score of one was given for every correct response. Responses like proper nouns, slang words and repetition of responses were omitted from scoring.

### 3.4 Phases in the study

**Phase I:** A pilot study was carried out for the tasks mentioned. A total of ten participants (two in each group: one bilingual and multilingual) were taken for the pilot study. The participants were divided into 4 groups (7-9 years; 9-11years, 11-13 years and 13-15years). Suitable modifications were made for the lexical access picture naming task. A familiarity check was carried out and based on which the 7 pictures which the participants were removed from the picture naming task.

No other modifications were made in the testing procedure.

**Phase II:** The following aspects were assessed: working memory, executive control and lexical access in the participants. The tasks involving lexical access were carried out in both Kannada and English.

### 3.5 Analysis

The data obtained from all the participants on Simon task was stored. The obtained reaction times and accuracy for each participant were grouped into congruent and incongruent trials. The error responses (negative) were omitted and mean reaction time was calculated for each participant. Simon effect was calculated by subtracting the mean reaction time of the congruent trial from the incongruent trial. Accuracy was calculated based on the number of correct responses.

The scores obtained on the Children's memory scale were tabulated on the score sheet and was later converted into percentages. For the picture naming task, the data obtained from all the participants were stored. The Check vocal software was used to analyze the verbal responses and the reaction time was obtained for each stimulus. The software provided the option of recording the responses in a time window of 5000ms. The onset of each of the named response was visually inspected using a spectrogram and was marked accordingly. This was noted as the reaction time. The responses were judged as correct, wrong or no response.

In the letter fluency and category fluency tasks the recorded responses were analyzed by the investigator. A score of one was given for every correct response. The responses were analyzed according to the target language. Responses like proper nouns, slang words and repetition of responses were omitted from scoring.

# CHAPTER 4

# RESULTS

The present study aimed to investigate the cognitive control in bilingual and multilingual children as they perform similar tasks. The participants in the two groups i.e., Group 1- Bilingual children , Group 2- Multilingual children were administered executive function, working memory and lexical access tasks individually and the performance of these tasks was compared within the groups and across the groups(7-9years,9-11years,11-13years,13-15years). The data collected from both the groups of children was averaged, tabulated and subjected to statistical measures. The statistical tests were performed using Statistical package for Social Science Software (SPSS version 18.0).

The following statistical procedures were used in the study:

1. Descriptive statistical procedures were used to compute the mean and standard deviation values in both the groups across the tasks.
2. Mixed ANOVA was used compare the main effect of groups, age groups and language and interaction between them.
3. Two way MANOVA was used for within task comparisons across each of the groups and age groups.
4. Two way ANOVA was used to compare age groups and groups across the tasks.

The findings of the study can be discussed under the following headings:

I. Quantitative performance of mean reaction times and accuracy on Simon task between bilingual and multilingual children across age groups.
II. Quantitative performance of working memory tasks between bilingual and multilingual children across age groups.
III. Quantitative performance of mean reaction times and accuracy on picture naming task between bilingual and multilingual children across the age groups.
IV. Quantitative performance of letter fluency and category fluency tasks between bilingual and multilingual children across age groups.

## 4.1 Quantitative performance of the mean reaction times and accuracy scores on Simon task across group1 and group2 across age groups

### *4.1.1. Comparison of mean reaction times on Simon task for group 1 and group 2 across age groups*

The mean and standard deviation values of reaction time on the Simon task for bilingual and multilingual groups were computed using descriptive statistics across the age groups and these values are represented in Table 4.1. On comparing the mean values of both the groups on the Simon task for the congruent and incongruent trials there was no difference across the means in the two groups.

Two way MANOVA was done to compare reaction times obtained in the Simon task across the two groups (Group 1 and Group2) and across the four age groups (7-9years, 9-11years, 11-13years, 13-15years) and across congruency. The mean values were subjected to Two way MANOVA which revealed no significant differences between Group 1 and Group 2 (Bilingual children vs. Multilingual children) [$F(1,72) = 2.745$, $p>0.05$] on the congruent tasks as well as the incongruent tasks [ $F(1,72)=3.720, p>0.05$]. However, on comparison of the congruent and incongruent trials within the group across the age groups, there was a significant difference in the congruent trials [$F(3, 72) = 11.72$; $p<0.05$] and incongruent trials [$F(3, 72) = 7.57$, $p<0.05$]. (Table 4.2 represents F-value and p-value for Simon mean reaction times in group 1 and group 2 across age groups)

**Table 4.1**

*Mean and standard deviation (SD) of reaction times for group 1 and group 2 across age groups.*

| **Simon Task** | **Age groups** | **N** | **Group 1** | | **Group 2** | |
|---|---|---|---|---|---|---|
| | | | **Mean** | **SD** | **Mean** | **SD** |
| Congruent trials | 7-9 | 10 | 714.80 | 149.61 | 761.63 | 30.22 |
| | 9-11 | 10 | 645.18 | 150.76 | 608.32 | 52.91 |
| | 11-13 | 10 | 659.46 | 85.21 | 560.11 | 76.02 |
| | 13-15 | 10 | 588.16 | 95.02 | 531.96 | 79.37 |
| Incongruent trials | 7-9 | 10 | 731.15 | 204.00 | 742.52 | 132.72 |
| | 9-11 | 10 | 651.21 | 142.46 | 650.06 | 68.78 |
| | 11-13 | 10 | 709.80 | 44.78 | 536.71 | 40.49 |
| | 13-15 | 10 | 582.95 | 120.63 | 543.55 | 86.57 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.2**

*Comparison of Simon task mean reaction times for group1 and group 2 across age groups*

| Simon Task | Group 1 vs. Group 2 | | Age groups | |
|---|---|---|---|---|
| | F value (1,72) | p value | F value (3,72) | p value |
| Congruent trials | 2.745 | 0.102 | 11.72 | **0.000*** |
| Incongruent trials | 3.720 | 0.058 | 7.57 | **0.000*** |

Group 1: Bilingual children; Group 2: Multilingual children; *p<0.05

*4.1.2. Comparison of accuracy scores on Simon task for group 1 and group 2 across age groups*

The mean and standard deviation values of accuracy scores on the Simon task for bilingual and multilingual groups were computed using descriptive statistics across the age groups and these values are represented in Table 4.3. There was no difference in mean scores for both the groups on the Simon task. Accuracy on the Simon task was compared across the groups and age groups using Mixed ANOVA which revealed no significant difference across group 1 and group 2 [$F(1,72)= 0.145$; $p > 0.05$] and also across age groups [$F(1,72)=1.578$; $p>0.05$].

Though there were no group differences on accuracy scores when the mean scores were compared within each group across the congruent and incongruent trials, it was found that the mean values were higher for congruent trials indicating better accuracy for congruent trials compared to incongruent trials. Mixed ANOVA administered revealed a significant difference in accuracy scores across the congruent and incongruent trials within each group [F (1, 72) =11.88; p<0.05].

(Table 4.4 represents Comparison of accuracy scores on Simon task across group 1 and group2 and across age groups with p value and F value)

**Table 4.3**

*Mean and standard deviation (SD) of accuracy scores on Simon task for group 1 and group 2 across age groups.*

| **Groups** | **Age Groups** | **N** | **Accuracy** | | | |
|---|---|---|---|---|---|---|
| | | | **Congruent Trials** | | **Incongruent Trials** | |
| | | | **Mean** | **SD** | **Mean** | **SD** |
| Group 1 | 7-9 years | 10 | 13.30 | 0.48 | 12.90 | 1.44 |
| | 9-11 years | 10 | 13.30 | 0.82 | 12.80 | 1.03 |
| | 11-13 years | 10 | 13.30 | 0.67 | 13.60 | 0.51 |
| | 13-15 years | 10 | 13.70 | 0.67 | 13.30 | 1.15 |
| Group 2 | 7-9 years | 10 | 13.70 | 0.48 | 12.80 | 1.31 |
| | 9-11 years | 10 | 13.40 | 0.84 | 12.90 | 1.19 |
| | 11-13 years | 10 | 13.70 | 0.48 | 13.00 | 1.05 |
| | 13-15 years | 10 | 13.70 | 0.67 | 13.50 | 0.84 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.4**

*Comparison of accuracy scores on Simon task across group 1 and group2 and across age groups*

| **Simon Accuracy** | **F value** | **p value** |
|---|---|---|
| Group 1 vs. Group 2 | 0.145 | 0.705 |
| Age groups | 1.578 | 0.202 |

Group 1: Bilingual children; Group 2: Multilingual children

## 4.2 Quantitative performance on working memory task for group 1 and group 2 across age groups

The scores obtained on the picture location subtest were converted into percentages. The mean and standard deviation were calculated for each of the two groups for working memory tasks administered using picture location subtest of Children's Memory Scale (CMS) and are represented in Table 4.5. Two way ANOVA was done to compare the working memory performance on CMS across group1 and group2 and also across the age groups. There was no significant difference in the scores across group 1 and group2 [$F (1, 72) = 3.05$; $p > 0.05$]. However, there was a significant difference in the working memory performance across the age groups. It was found that there was no significant difference only across the pairs of 9-11years and 11-13 years, rest of the pairs had a significant difference [$F (3, 72) = 92.60$; $p < 0.05$]. The F value and the p value are represented in Table 4.6

**Table 4.5**

*Mean and SD values for working memory performance for group 1 and group 2 across age groups.*

| **Groups** | **Age Group** | **Mean** | **SD** | **N** |
|---|---|---|---|---|
| Group 1 | 7-9 years | 80.43 | 5.06 | 10 |
| | 9-11 years | 92.63 | 1.97 | 10 |
| | 11-13 years | 92.77 | 2.34 | 10 |
| | 13-15 years | 95.69 | 3.36 | 10 |
| Group 2 | 7-9 years | 80.41 | 4.98 | 10 |
| | 9-11 years | 95.27 | 1.98 | 10 |
| | 11-13 years | 93.60 | 3.54 | 10 |
| | 13-15 years | 97.49 | 1.57 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.6**

*Comparison of working memory scores across groups and age groups*

| **Working memory (CMS)** | **F value** | **p value** |
|---|---|---|
| Group 1 vs. Group 2 | 3.05 | 0.08 |
| Age groups | 92.60 | **0.000*** |

Group 1: Bilingual children; Group 2: Multilingual children**;***p<0.05

## 4.3 Quantitative performance of Picture Naming mean reaction times across group 1 and group 2 and age groups

The mean and standard deviation values calculated for picture naming mean reaction times in Kannada and English are tabulated in Table 4.7 and Table 4.8

respectively. The participants in group 2 had higher mean values than group 1 participants indicating slower reaction times in multilinguals. But this was not statistically supported. Mixed ANOVA was administered to compare the mean reaction times of the participants across group 1 and group 2. There was no significant difference in naming reaction times across group 1 and group 2 [ $F(1,72) = 0.573, p > 0.05$] but there was a significant difference in naming reaction times across the age groups within each group [$F(1,72) = 3.287, p < 0.05$].

Further, Two way MANOVA was administered to find out if there were differences in picture naming in both Kannada and English within the groups. There was a significant difference noted in picture naming-English across the age groups [$F (1, 72) = 3.734, p<0.05$)] excepting the 9-11 years and the 11-13 years which performed very similar whereas in Kannada there was no significant difference observed [$F (1, 72) = 0.133, p > 0.05$)]. When the picture naming was compared within the group across the two languages, the mean values were higher in English compared to Kannada and statistically also there was a significant difference noted [$F (1, 72) = 8.011, p<0.05$)]. (Table 4.9 represents comparison of picture naming reaction times across the two languages)

**Table 4.7**

*Mean and standard deviation values for reaction times of Picture naming in Kannada for Group 1 and Group 2 across age groups.*

| **Picture Naming-Kannada** | **Age Groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|
| Group 1 | 7-9 years | 131.50 | 57.28 | 10 |
| | 9-11 years | 100.40 | 55.97 | 10 |
| | 11-13 years | 172.57 | 62.63 | 10 |
| | 13-15 years | 142.67 | 89.80 | 10 |
| Group 2 | 7-9 years | 149.78 | 110.65 | 10 |
| | 9-11 years | 140.32 | 182.96 | 10 |
| | 11-13 years | 119.57 | 52.33 | 10 |
| | 13-15 years | 178.18 | 240.09 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.8**

*Mean and standard deviation values for reaction times of Picture naming in English for Group 1 and Group 2 across age groups.*

| **Picture Naming-English** | **Age Groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|
| Group 1 | 7-9years | 206.47 | 87.13 | 10 |
| | 9-11years | 163.15 | 60.29 | 10 |
| | 11-13years | 253.33 | 135.29 | 10 |
| | 13-15years | 190.92 | 92.33 | 10 |
| Group 2 | 7-9years | 135.34 | 68.16 | 10 |
| | 9-11years | 75.03 | 33.21 | 10 |
| | 11-13years | 270.04 | 68.75 | 10 |
| | 13-15years | 175.81 | 127.60 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.9**

*Comparison of Picture naming mean reaction times across Kannada and English and across age groups*

| **Picture Naming** | **F value** | **p value** |
|---|---|---|
| Language<br>(Kannada vs English) | 8.011 | **0.006*** |
| Age groups | 2.965 | **0.038*** |

*(p<0.05)

**Table 4.10**

*Comparison of Picture naming reaction times across group 1 and group 2 and across age groups*

| **Picture Naming** | **F value** | **p value** |
|---|---|---|
| Group 1 vs. group 2 | 0.573 | 0.457 |
| Age groups | 3.287 | **0.025*** |

*(p<0.05)

### 4.4 Quantitative performance of picture naming accuracy scores across group 1 and group2

The accuracy scores on picture naming were compared across the two groups, age groups and two languages using mixed ANOVA. The mean and standard deviation values for accuracy of picture naming in Kannada and English for group 1 and group 2 across age groups are represented in Table 4.11 and 4.12 respectively. There was a significant difference in picture naming accuracy across group 1 and group 2 [F (1, 72) = 8.46, p<0.05]. A significant difference in picture naming accuracy across age groups was also obtained [F (3, 72) = 29.77, P<0.05].

Two way MANOVA was done to compare the picture naming performance within each group and across the age groups in each group. It was noted that in picture naming accuracy-Kannada there was a significant difference observed across the groups [F(1,72)= 4.493,p<0.05] whereas in English there was no significant difference [F(1,72)=3.813,p>0.05]. A significant difference was observed in picture naming of both Kannada [F(3,72)= 16.98,p<0.05] and English [F(3,72)= 12.20,p<0.05] across the age groups and there was no interaction effect between groups, age groups and languages.

(Table 4.13 represents comparison of Picture naming accuracy scores between group1 and group 2 and across age groups)

**Table 4.11**

*Mean and SD for accuracy of picture naming-Kannada for group 1 and group 2 across age groups*

| **Picture Naming-Kannada** | **Age Groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|
| Group 1 | 7-9 years | 24.50 | 4.71 | 10 |
| | 9-11 years | 26.50 | 7.82 | 10 |
| | 11-13 years | 31.50 | 3.92 | 10 |
| | 13-15 years | 37.30 | 5.31 | 10 |
| Group 2 | 7-9 years | 21.30 | 6.32 | 10 |
| | 9-11 years | 26.00 | 7.11 | 10 |
| | 11-13 years | 28.80 | 3.99 | 10 |
| | 13-15 years | 32.90 | 5.08 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.12**

*Mean and SD for accuracy of picture naming-English for group 1 and group 2 across age groups*

| Picture Naming-English | Age Groups | Mean | SD | N |
|---|---|---|---|---|
| Group 1 | 7-9 | 35.30 | 6.49 | 10 |
| | 9-11 | 35.90 | 6.59 | 10 |
| | 11-13 | 38.50 | 2.87 | 10 |
| | 13-15 | 40.90 | 2.72 | 10 |
| Group 2 | 7-9 | 29.70 | 1.33 | 10 |
| | 9-11 | 35.10 | 5.62 | 10 |
| | 11-13 | 37.60 | 3.43 | 10 |
| | 13-15 | 40.40 | 3.59 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.13**

*Comparison of Picture naming accuracy between group1 and group 2 and across age groups*

| Picture Naming accuracy | F value | p value |
|---|---|---|
| Group 1 vs. group 2 | 8.46 | **0.005*** |
| Age groups | 29.77 | **0.000*** |

*p<0.05

## 4.5 Quantitative performance on category fluency across and within groups

Mean and standard deviation values for category fluency-Kannada and English for the lexical categories of animals and fruits for group 1 and group 2 across age groups were calculated and represented in Table 4.14 and Table 4.15 respectively. Mixed ANOVA was administered to compare the category fluency tasks across groups, age groups, languages and across the categories. There was no significant difference in the category fluency task across group 1 and group 2 [$F(1, 72) = 0.96$, $p>0.05$]. However, there was a significant difference in category fluency tasks across the age groups in both Kannada and English [$F(3, 72) = 44.11$, $p<0.05$].

Within the group, there was a significant difference obtained across the languages and across the categories. A significant difference was also obtained across the age groups [$F(3, 72) = 3.45$, $p<0.05$] indicating a developmental trend. (Table 4.16 represents the comparison of category fluency across group1 and group 2 across age groups and interaction of group vs. age group).

**Table 4.14**

*Mean and SD values for category fluency-Kannada for the Lexical categories of animals and fruits for group 1 and group 2 across age groups*

| **Category fluency-Kannada** | **Groups** | **Age groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|---|
| Animals | Group 1 | 7-9 | 8.70 | 3.71 | 10 |
| | | 9-11 | 10.00 | 4.18 | 10 |
| | | 11-13 | 13.00 | 2.44 | 10 |
| | | 13-15 | 15.40 | 3.13 | 10 |
| | Group 2 | 7-9 | 6.10 | 1.91 | 10 |
| | | 9-11 | 10.80 | 3.48 | 10 |
| | | 11-13 | 13.30 | 2.00 | 10 |
| | | 13-15 | 14.40 | 1.71 | 10 |
| Fruits | Group 1 | 7-9 | 5.30 | 2.05 | 10 |
| | | 9-11 | 5.80 | 2.09 | 10 |
| | | 11-13 | 8.30 | 1.41 | 10 |
| | | 13-15 | 9.70 | 2.49 | 10 |
| | Group 2 | 7-9 | 4.60 | 0.84 | 10 |
| | | 9-11 | 6.60 | 1.83 | 10 |
| | | 11-13 | 7.30 | 1.56 | 10 |
| | | 13-15 | 7.90 | 3.107 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.15**

*Mean and SD values for category fluency-English for the Lexical categories of animals and fruits for group 1 and group 2 across age groups*

| **Category fluency-English** | **Groups** | **Age groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|---|
| Animals | Group 1 | 7-9 years | 10.80 | 3.48 | 10 |
| | | 9-11 years | 12.90 | 3.66 | 10 |
| | | 11-13 years | 14.80 | 1.81 | 10 |
| | | 13-15 years | 18.20 | 3.70 | 10 |
| | Group 2 | 7-9 years | 6.00 | 0.66 | 10 |
| | | 9-11 years | 14.70 | 3.86 | 10 |
| | | 11-13 years | 15.90 | 5.76 | 10 |
| | | 13-15 years | 18.50 | 2.12 | 10 |
| Fruits | Group 1 | 7-9years | 6.60 | 2.36 | 10 |
| | | 9-11 years | 7.30 | 1.88 | 10 |
| | | 11-13years | 7.30 | 1.41 | 10 |
| | | 13-15years | 10.60 | 1.71 | 10 |
| | Group 2 | 7-9 years | 5.40 | 1.42 | 10 |
| | | 9-11years | 7.60 | 1.83 | 10 |
| | | 11-13years | 9.60 | 3.06 | 10 |
| | | 13-15years | 9.60 | 3.30 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.16**

*Comparison of category fluency across group1 and group 2 across age groups and interaction of group vs. age group*

| **Category fluency** | **F value** | **P value** |
|---|---|---|
| Group 1 vs. group 2 | 0.96 | 0.328 |
| Age groups | 44.11 | **0.00*** |
| Group vs. Age group | 3.45 | **0.02*** |

*p<0.05

## 4.6 Quantitative performance on letter fluency for Group 1 and Group 2 across age groups

Mean and standard deviation values for the letter fluency tasks in Kannada for phonemes /p/, /s/ and /t/ across groups and age groups are depicted in Table 4.17, Table 4.18 and Table 4.19 respectively. Mean and standard deviation values for the letter fluency tasks in English for letters /F/, /A/ and /S/ across groups and age groups are depicted in Table 4.20, Table 4.21 and Table 4.22 respectively.

Two way MANOVA was used to compare letter fluency tasks across group 1 and group 2 and across age groups. Group comparisons revealed no significant difference in letter fluency tasks between group 1 and group2 across the phonemes /p/ [F (1, 72) = 2.12, p>0.05], /s/ [F (1, 72) = 1.14, p>0.05], /t/ [F (1, 72) = 0.02, p>0.05] in Kannada and letters /F/ [F (1, 72) = 1.41, p>0.05], /A/ [F (1, 72) = 2.39, p>0.05] and /S/ [F (1, 72) = 2.86, p>0.05] in English.

However, within the groups, there was a significant difference in letter fluency performance across the age groups for phonemes /p/ [F (3, 72) = 24.61, p<0.05], /s/ [F (3, 72) = 22.90, p<0.05], /t/ [F (3, 72) = 15.84, p<0.05] in Kannada and letters /F/ [F

(3, 72) = 12.01, p<0.05], /A/ [F (3, 72) = 19.30, p<0.05] and /S/ [F (3, 72) = 21.83, p<0.05] in English. When group1 and group 2 were compared across age groups, it was found that there was a significant difference only on the performance of letter A [F (3, 72) = 4.40, p<0.05] in English. (Comparison of letter fluency across group 1 and group2, across age groups and group vs. age groups is depicted in Table 4.23)

**Table 4.17**

*Mean and SD for letter fluency for Kannada phoneme /p/ for group 1 and group 2 across age groups*

| **Letter Fluency-Kannada** | **Groups** | **Age groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|---|
| /p/ | Group 1 | 7-9 | 3.40 | 1.50 | 10 |
| | | 9-11 | 6.90 | 2.33 | 10 |
| | | 11-13 | 9.00 | 2.10 | 10 |
| | | 13-15 | 11.40 | 3.50 | 10 |
| | Group 2 | 7-9 | 3.60 | 0.69 | 10 |
| | | 9-11 | 7.10 | 1.96 | 10 |
| | | 11-13 | 6.40 | 1.57 | 10 |
| | | 13-15 | 10.10 | 5.13 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.18**

*Mean and SD for letter fluency for Kannada phoneme /s/ for group 1 and group 2 across age groups*

| Letter Fluency-Kannada | Groups | Age groups | Mean | SD | N |
|---|---|---|---|---|---|
| /s/ | Group 1 | 7-9 years | 5.20 | 2.39 | 10 |
| | | 9-11 years | 7.90 | 1.85 | 10 |
| | | 11-13years | 8.20 | 3.01 | 10 |
| | | 13-15years | 10.80 | 2.93 | 10 |
| | Group 2 | 7-9years | 3.60 | 1.17 | 10 |
| | | 9-11years | 9.00 | 2.21 | 10 |
| | | 11-13years | 9.50 | 1.84 | 10 |
| | | 13-15years | 12.70 | 5.22 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.19**

*Mean and SD for letter fluency for Kannada phoneme /t/ for group 1 and group 2 across age groups*

| Letter Fluency-Kannada | Groups | Age groups | Mean | SD | N |
|---|---|---|---|---|---|
| /t/ | Group 1 | 7-9 years | 4.20 | 2.34 | 10 |
| | | 9-11years | 7.30 | 2.62 | 10 |
| | | 11-13years | 7.40 | 1.26 | 10 |
| | | 13-15years | 10.10 | 4.53 | 10 |
| | Group 2 | 7-9years | 3.30 | 1.15 | 10 |
| | | 9-11years | 7.70 | 2.98 | 10 |
| | | 11-13years | 8.50 | 1.90 | 10 |
| | | 13-15years | 9.90 | 4.48 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.20**

*Mean and SD for letter fluency for English letter /F/ for group 1 and group 2 across age groups*

| Letter Fluency-English | Groups | Age groups | Mean | SD | N |
|---|---|---|---|---|---|
| F | Group 1 | 7-9 years | 6.40 | 2.41 | 10 |
| | | 9-11years | 10.10 | 2.92 | 10 |
| | | 11-13years | 8.70 | 2.62 | 10 |
| | | 13-15years | 9.60 | 2.22 | 10 |
| | Group 2 | 7-9years | 5.50 | 2.12 | 10 |
| | | 9-11years | 9.80 | 2.61 | 10 |
| | | 11-13 years | 10.10 | 3.17 | 10 |
| | | 13-15years | 12.40 | 4.00 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.21**

*Mean and SD for letter fluency for English letter /A/ for group 1 and group 2 across age groups*

| Letter Fluency-English | Groups | Age groups | Mean | SD | N |
|---|---|---|---|---|---|
| A | Group 1 | 7-9 years | 5.10 | 1.52 | 10 |
| | | 9-11years | 8.00 | 2.53 | 10 |
| | | 11-13years | 8.40 | 0.69 | 10 |
| | | 13-15years | 8.70 | 2.71 | 10 |
| | Group 2 | 7-9years | 5.60 | 1.07 | 10 |
| | | 9-11years | 7.40 | 0.96 | 10 |
| | | 11-13years | 7.80 | 3.29 | 10 |
| | | 13-15years | 12.40 | 2.83 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.22:** *Mean and SD for letter fluency for English phoneme /S/ for group 1 and group 2 across age groups*

| **Letter Fluency-English** | **Groups** | **Age groups** | **Mean** | **SD** | **N** |
|---|---|---|---|---|---|
| S | Group 1 | 7-9years | 6.50 | 2.67 | 10 |
| | | 9-11years | 10.60 | 3.68 | 10 |
| | | 11-13years | 10.80 | 3.29 | 10 |
| | | 13-15years | 11.30 | 3.33 | 10 |
| | Group 2 | 7-9years | 4.10 | 1.19 | 10 |
| | | 9-11years | 11.80 | 3.35 | 10 |
| | | 11-13years | 13.30 | 3.74 | 10 |
| | | 13-15years | 15.10 | 4.62 | 10 |

Group 1: Bilingual children; Group 2: Multilingual children

**Table 4.23**

*Comparison of letter fluency across group 1 and group2, across age groups and group vs. age groups*

| **Letter Fluency** | **Phonemes** | **F value** | **p value** |
|---|---|---|---|
| Groups | /p/ | 2.12 | 0.149 |
| | /s/ | 1.14 | 0.289 |
| | /t/ | 0.02 | 0.879 |
| | F | 1.41 | 0.238 |
| | A | 2.39 | 0.126 |
| | S | 2.86 | 0.09 |
| Age groups | /p/ | 24.61 | **0.000*** |
| | /s/ | 22.90 | **0.000*** |
| | /t/ | 15.84 | **0.000*** |
| | F | 12.01 | **0.000*** |
| | A | 19.30 | **0.000*** |
| | S | 21.83 | **0.000*** |
| Group vs. Age group | /p/ | 1.26 | 0.29 |
| | /s/ | 1.51 | 0.21 |
| | /t/ | 0.42 | 0.73 |
| | F | 1.76 | 0.16 |
| | A | 4.40 | **0.007*** |
| | S | 3.13 | 0.03 |

Group 1: Bilingual children; Group 2: Multilingual children**;***p<0.05

# CHAPTER 5

# DISCUSSION

The goal of the present study was to investigate the cognitive control in typically developing bilingual and multilingual children. Cognitive control was investigated under the following domains - executive function, working memory and lexical access. The tasks employed under executive function and working memory were Simon task and Picture location subtest of Children's memory scale respectively. Lexical access was investigated using picture naming, category fluency and letter fluency tasks. Each of these tasks was compared across the bilingual and multilingual group. It was also of interest to examine the developmental trend in each of the groups.

## 5.1 Comparison of Simon task and CMS across and within groups

### *5.1.1 Comparison of Simon task across and within groups*

In the Simon task, within groups there were differences across the congruent and incongruent trials with the response latencies longer in the incongruent case than the congruent condition. Across the two groups, it was observed that both the groups performed similar across the congruent and incongruent trials.

In the present study, Simon task was carried out on a set of 28 trials with four practice trials. It could be that prolonged practice on the Simon task might have reduced the difference in performance across the groups. This is in consonance with results found by Bialystok et al (2004) on monolingual and bilingual population where prolonged practice on the Simon task reduced the difference between monolinguals and bilinguals. Hence, it can be speculated that with sufficient practice everyone can inhibit the competing information. However, we may not arrive at any conclusive remark based on these results as the measures chosen may not have been sensitive enough to tap inhibitory control.

*5.1.2. Comparison of CMS across and within group*

The results of the working memory tasks reveal no significant difference of the CMS scores across the groups. This is in consonance with previous research comparing monolinguals and bilinguals where the researchers have sometimes found a bilingual advantage (Bialystok et al., 2004) and sometimes found no relationship (Bajo et al., 2000). There are studies which suggest that working memory may be a group of related constructs rather than a unitary entity and because of which various tests of working memory do not correlate with each other (Daneman & Tardif ,1987) and this would be especially true in case of spatial working memory tasks as compared to verbal working memory (Baddeley,1986).

One more possible reason is that working memory tasks utilize common frontal lobe areas which work in agreement with task specific posterior areas (Cowan, 2005). From this view it is possible that different working memory tasks may have been differentially affected by bilingualism. While, it is difficult to derive a conclusive remark at this point, it may be interesting to explore it in future research.

## 5.2 Lexical access across and within the two groups

### *5.2.1. Picture Naming performance within and across group1 and group 2*

In the picture naming task, there was no significant difference observed in the mean reaction times across the bilingual and multilingual groups. It was hypothesized that multilinguals would perform poorer than the bilinguals on the picture naming tasks. This is because, in multilinguals it may be that more than two languages are active at a given point in time and it was expected to result in cross language interference.

But this was not the case in the findings of the present study. The bilingual and multilingual groups performed similar on the reaction time measures. There are several reasons which can be postulated to explain these findings. Presumably, this is due to the reason that the language proficiency of the multilinguals in the three languages are not always identical. It was hypothesized that the proficiency in the third language may not have been sufficient enough to create a multilingual disadvantage over the bilinguals. However, when a within group comparison was made there was an increase in reaction times with age in English indicating a developmental trend.

There was also a significant difference in naming reaction times within the two groups across Kannada and English with reaction times being faster in Kannada compared to English. The plausible reason for this could be that because of their ability to inhibit their second language and third languages which means to say that they may have better inhibitory control. But this was not reflected in their executive function and working memory performance or it may be possible that the task chosen for executive function and working memory was sensitive enough to tap inhibitory control. Thus, it is difficult to draw any conclusive evidence from this.

In the present study, there was a significant difference in the performance of naming accuracy in Kannada across bilinguals and multilinguals. There is a dearth of studies in this regard comparing bilingual and multilingual children, while support is drawn from studies on monolingual and bilingual comparisons. This is in consonance with research on bilingual and monolinguals which show that bilingual participants take longer time and make more errors than monolinguals on naming tasks (Roberts, Garcia, Desrochers , & Hernandez,2002;Gollan, Fennema-Notestine, Montoya & Jennigan,2007). A simple act of retrieving a common word seems to be effortful for bilinguals. Hence it can be hypothesized that such a process of retrieving may be more effortful for a multilingual than a bilingual if they are not proficient in their languages.

Gollan and colleagues argue that the essential feature of bilingual representations is the “weaker links” that are established within the network because of probable less frequent use of each language (Gollan, Montoya, Cera, & Sandoval, 2008). This would be applicable to multilingual language representation as well. Multilinguals rarely use their language equally frequently in every domain of the social environment. They use each language in different contexts for different purpose and probably in variable strengths. Thus, cross language interference was not strong enough to cause a multilingual disadvantage.

Also there may be numerous issues of variability in the acquisition of third language in the multilinguals amongst which the speaker’s language proficiency and relative balance between the two languages, the intensity of daily usage of each of the three languages, length of exposure, age of L2 and L3 acquisition, the degree of similarity between a bilingual’s two languages, and specificities related to the context in which both languages are being used on a daily bases and mastery of language play a very important role. This can be explained by the fact that the knowledge base from which all language processing proceeds is less rich or less interconnected for a bilingual in each language than it is for a monolingual speaker for one of those languages.

The current study also reveals a significant difference in the accuracy of picture naming in Kannada (L1) and English (L2) in both the groups. This could be attributed to several factors like the environmental exposure, the medium of instruction at school and commonly used labels. In the current scenario, the medium of instruction in Schools is majorly English and most of the parents also speak to their children mostly in English (L2) at home. The labels used for most of the common objects are also in English. All these factors could have possibly led to L1 attrition and hence the difference in accuracy may have been noted.

Another plausible reason could be that cross-linguistic cognates are also quasi redundantly represented in each subsystem i.e., a particular word may be available to a bilingual but not it’s cognate in the other language. This difficulty would be more pronounced in the multilingual where the person has to constantly juggle between three or more languages. Other possible reason could be that the lexical meanings and also the pronunciations across Kannada and English are very rarely identical.

*5.2.2. Comparison of category fluency and letter fluency across and within groups*

The results of the current study indicate that there was no significant difference in category fluency and letter fluency across the groups. A plausible reason could be that in both bilinguals and multilinguals there is a set of restrictions imposed to exclude repetitions of words which requires intensive monitoring and working memory. Because there is a time limit of 60 seconds, it might restrict the bilingual and multilingual performance. Also the participants in both bilingual and multilingual group have to deal with competition from the other language which is supported by the bilingual spreading activation principle of lexical access (DeBot, 1992, Green, 1986, 1998; Poulisse & Bongaerts, 1994).

In the multilinguals the competition from the other two languages may not have been high enough to cause interference. However a further probe into the errors reveals mostly substitution of translational equivalents. This implies that both the groups also derive support from the other language/s. There was also a difference in performance across the languages seen in both the groups which might be attributed to the frequency of usage of each of the languages. On the letter fluency task there was an age wise difference across the letters observed in both the groups indicating a developmental trend.

*5.2.3. Developmental Trend in bilingual and multilingual children*

In the present study, the mean reaction times, accuracy measures and scores on each of the tasks were compared across the age groups from seven to fifteen years. The results reveal that there was a significant difference obtained across age groups for most of the tasks.

The mean reaction times on the Simon task were compared on the basis of congruency across the four age groups which revealed a significant difference between the congruent and incongruent trials across the age group. There was an age related decrease in the mean reaction times across the age groups suggesting that the older children (13-15years) performed faster than the younger children (7-9 years). However, when the accuracy scores were compared across the ages there was no significant difference. On the working memory task, it was found that except the 9-11 and 11-13 age groups there was a significant difference across all the other age groups.

Even on comparison of picture naming mean reaction times across the age groups there was no significant difference across 9-11 years and 11-13 years but all other age groups showed age related decrease in the reaction times. This could be possibly due to the reason that there may not be a drastic maturational change happening during this period. However, a further deep investigation would shed more light on this. The results of the picture naming accuracy scores comparison across the age groups also indicates an age related increase in the accuracy performance with age. Also, the performance of the bilingual and multilingual children in both the category and the letter fluency tasks indicate a significant difference across the age groups. This is suggestive of the notion that children gradually master the ability to control attention, inhibit distraction, monitor sets of stimuli, learning vocabulary and shift between tasks. Thus, by and large, there is a developmental trend exhibited on almost all of the tasks.

# CHAPTER 6

# SUMMARY AND CONCLUSIONS

Bilingualism and multilingualism, in recent times, has largely become the rule and not an exception due to the global expansion. In India however this has always been the case due to the vast history and cultural differences. There has been extensive research in the past comparing the cognitive control abilities in monolingual and bilingual populations with bilinguals having better cognitive control than monolinguals. But there has been a dearth of studies in this regard comparing cognitive control in bilingual and multilingual children. Hence the present study is the first of its kind to explore whether there is a multilingual advantage over a bilingual one.

The current study aimed to investigate the cognitive control in Kannada-English bilingual and Kannada-English-any other language multilingual children. A total of eighty participants in the age range of 7-15 years were divided into two groups with group 1 having fourty bilingual children and group 2 including fourty multilingual children. The participants in each of the group were further divided into subgroups (7-9years, 9-11years, 11-13years, 13 -15years). The participants were screened on WHO Ten questions disability screening checklist' (Singhi, Kumar, Malhi, and Kumar, 2007) and International Second Language Proficiency Rating Scale (ISLPR) **(**Wylie and Ingram, 2006).

A comparison of cognitive control was made across Group 1 and Group 2 on a battery of tasks under the domains of executive function, working memory and lexical access. The executive function task included the Simon task, working memory was tested using Picture locations subtest of Children's Memory Scale, lexical access was tested using picture naming, category fluency and letter fluency tasks. The tasks under lexical access were performed both in Kannada and English.

The reaction times and accuracy scores obtained on the Simon task and picture location subtest of Children's memory scale were noted. The reaction times as well as the accuracy scores were noted. For the picture locations subtest of children's memory scale the participant was shown a stimulus page with pictures placed in various locations within a rectangle. The stimulus page was then removed from view, and the examinee was asked to place the response chips on the response grid in the same locations as the pictures appeared on the stimulus page. Recording was done using a record form grid.

For the category fluency task the participants were required to name as many items as possible belonging to a particular taxonomic category within a minute. The letter fluency task they were asked to name as many words as possible starting with letter /p/, /s/ and /t/ in kannada within a minute and similarly for letters F, A, S in English. A score of one was given for each correct response in both the tasks.

The responses obtained on each of the tasks were averaged and statistically analysed using SPSS software. MANOVA, Two way ANOVA, two way MANOVA, Mixed ANOVA were used to compare and contrast across the two groups and also for comparisons within the group. The results revealed no significant difference across both the groups on most of the tasks with an exception being picture naming accuracy in Kannada where there was a group difference that was statistically significant. However, in both the groups there was an age wise difference across most of the tasks indicating a developmental pattern.

## 6.1 Conclusions

On comparison of cognitive control in bilingual and multilingual children, there was no significant difference across majority of the tasks. This can be explained by the fact that in the participants considered as multilinguals, the third language proficiency may not be high enough to cause a multilingual advantage. Hence, this can be considered as a question for future research. However, in almost all of the tasks excepting the picture naming and Simon tasks there was an age wise pattern observed in all of the other tasks which is largely indicative of a developmental trend.

The findings of the study also indicate that there was significant difference in accuracy scores of picture naming in Kannada. Though, Kannada being the native language for all the participants each having a native like proficiency in the mother tongue, the errors were more pronounced in Kannada. This was explained with the reference to the change in the medium of instruction over the years with English being given more importance over Kannada. The parents also tend to converse mostly in English because of which the frequency of usage of Kannada has reduced over the years. Hence it can be concluded that with urbanization seeping in there is a demand to use English more frequently than Kannada which has led to L1 attrition.

## 6.2 Clinical Implications

1. From the findings an inference can be made of the differences in the cognitive control of bilingual and multilingual children.
2. The outcome may be reflective of the extent of influence of cognitive control across tasks that individually assess different aspects of cognition. This would add to the existing body of literature on cognitive influences.
3. The findings of the study on the several tasks chosen are responses obtained within a particular time limit. It would be interesting to know if the performance would change when there is no time constraint imposed.
4. This will also help in establishing a developmental trend of cognitive control from 7years to 15 years.
5. The same study can be carried out across different language impaired population to analyze which population has more impaired cognitive control. This knowledge will help in the assessment and treatment of bilingual or multilingual children with language impairment.

## 6.3 Limitations of the Study

The study had a few limitations which are as follows-

1. The working memory task employed in this study was a nonverbal working memory task. It would have been interesting to compare the performance of both the groups with a verbal working memory counterpart.
2. The L3 proficiency level considered for the multilingual group was low. Hence, a multilingual advantage may not be seen.

### 6.4 Future directions for research

1. A study on similar lines can be carried out across different clinical populations to investigate their performance on such tasks.

2. This study can be replicated using language proficiency as one of the variables and sub grouping the participants based on proficiency.

3. It would also be interesting to know how the performance on tasks of cognitive control would vary across the different types of bi/multilingual children and adults.

4. This study can be modified to investigate the influence of cognitive control on metalinguistic tasks like judgmental tasks.

5. This study can also be replicated in adult population to probe into the effects of aging on cognitive control in bilinguals and multilinguals.

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