Bilingualism and Cognition

The role of early bilingualism in the development of executive control and its influence on cognitive abilities

B.A. Essay

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Abstract

The topic of bilingualism and its influence on executive control development is an active field of research. Executive controls are high-level processes that affect an individual's ability to concentrate, shift between tasks and successfully complete various goal-directed performances such as those that support academic achievement. This paper discusses the effect of bilingualism on three primary executive controls, namely inhibition, working memory and cognitive flexibility. With a focus on early bilingualism, this paper reviews several studies on the consequences of early bilingual development on children's executive control. The main findings indicate that early bilingual children outperform monolingual children on tasks such as the Attention Network Task (ANT) and the Dimensional Change Card Sort task (DCCS) as well as other tasks requiring the use of executive control. These studies support the bilingual advantage hypothesis. The hypothesis suggests that bilingual children that have been exposed to two languages from an early age and continued to actively use two languages, develop increased inhibition control and task-switching abilities. Because of conflicting research outcomes in studies on the connection between early bilingual individual's performance on executive control tasks and working memory, this paper focuses mostly on early bilingual's inhibition control and cognitive flexibility. The studies reviewed in this paper presented consistent results regarding bilingual children's performance on tasks involving inhibition control. Inhibition processes, especially the ability to control attention from a distracting stimulus is of focus in this review since it is believed to influence the other two primary executive controls, working memory and cognitive flexibility. The paper examines how the bilingual experience, that is, the maintenance of two languages in the mind and the constant switching from one language to another language influences executive control. The final topic of this paper reviews and discusses how executive control influences individual's goal-directed performances relevant to academic achievement.
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1 Introduction

One of the first reports on bilingualism was presented in 1913 by Ronjat. It is estimated that more than half of the world’s population is multilingual to some degree (Bialystok, 2017). In the early 20th century, bilingualism was seen harmful to bilingual children's language development. With research and more sufficient methods for assessing bilingualism, the negative views started to change in the latter part of the 20th century (Peal & Lambert, 1962). Furthermore, studies have presented results suggesting that the bilingual experience might have an impact on cognitive abilities, resulting in what is known in the literature as; bilingual advantages (O. Adesope, Lavin, Thompson & Ungerleider, 2010). The bilingual advantages reviewed in this paper involve three major executive controls, that are, inhibition control, working memory and cognitive flexibility which are believed to influence other sub-controls that assist with abilities such as, concentration and shifting between tasks. Executive controls are not only a fundamental topic in contemporary literature on bilingualism but they also play an important role for individuals in general, for this reason, studies examining executive control and its relation to the bilingual experience are important and many. This paper aims at discussing the idea that bilingual advantages might commence very early, even before any speech production begins. The focus of this paper is on early bilinguals, a term used for describing bilingual individuals that have successfully used both their L1 and L2 from birth and continue to actively use both languages daily. Therefore, this paper discusses early bilingual individual's executive control development and how it might contribute to performances requiring the use of executive control, especially involving inhibition control and cognitive flexibility. Due to inconsistent research outcomes of the role that working memory plays in tasks requiring the use of executive control, this paper aims at discussing inhibition processes especially in terms of how early bilingual's might benefit from developing their attention control. In addition, attention control is believed to influence the other two primary executive controls, working memory and cognitive flexibility. In the last chapter, the practice of maintaining two languages in mind and constantly switching between the two will be discussed with the purpose of demonstrating how that practice influences inhibition,
attention control and cognitive flexibility. Therefore, this paper will begin with an overview of the rapid development of bilingual studies in the 20th century. In addition, the second chapter aims at presenting different variations of bilingual experiences and bilingual types as well as presenting the elements that need to be addressed when answering the question of who is bilingual. The third chapter reviews the major executive controls mentioned earlier, inhibition control, working memory and cognitive flexibility in a general manner. The final discussion summarizes the paper's overall review for explaining the positive influence of early bilingualism in the development of executive control and how this might affect academic achievement as a goal-directed performance.
2 Bilingualism

An individual that can switch effortlessly between two languages and adopt appropriate sociocultural stances for each of them is generally thought of as being bilingual (Bialystok, 2001). Contemporary research indicates that the equal usage of L1 and L2 might be very beneficial (Thomas-Sunesson, Hakuta & Bialystok, 2016). In addition, Baumgart and Billick (2017) stated that “Bilingualism is generally categorized by equal or near-equal proficiency in two languages that have been used regularly by the subject for the majority of their life” (p 273–283). Current views on bilingualism are positive, with dual-language acquisition being encouraged rather than suppressed. However, as this chapter will later review, bilingualism was once viewed as having negative effects on children's language development.

Due to bilingualism being a multidimensional experience, there is not one universally valid approach for distinguishing bilingualism and the criteria used for evaluating the bilingual degree vary between studies. More exactly, bilingualism can be thought of as an experience which, just like any other types of experiences, can greatly differ between individuals. For an example, some children might become bilingual adults because of early dual-language exposure whilst other children might become bilingual adults because of their second language acquisition in primary school. In addition, the reasons for applying a second language and the amount of usage in daily life contributes immensely to an individual’s bilingual experience. Therefore, the criteria employed in bilingual studies often aim at matching together bilingual and monolingual individuals that correspond in areas such as language proficiency, age and amount of second language usage. Although bilingual studies in the 21st century differ from the studies presented in the early 20th century in many aspects, the most notable change is the methods used for choosing which participants belong in the bilingual groups and which belong in the monolingual ones (Cummins, 2000; Luk, De Sa & Bialystok, 2011; Yanping & Ping, 2015; Anderson, Mak, Chahi & Bialystok, 2017).
2.1 Bilingualism Research in the 20th Century

Studies in the early 20th century on individuals becoming bilingual presented bilingual individuals as underachievers. Many of the studies on bilingualism in the earlier part of the 20th century assessed participants degree of bilingualism insufficiently and presented the phenomenon as a potential negative issue for children's language development. Since the early 20th century, the term bilingualism has taken a shift in meaning and expanded greatly as a subject in the field of linguistics.

Studies conducted before the 1960s were, for the most part, found to be negative in attitude towards bilingual education. Saer conducted a study on the connection between bilingualism and intelligence in 1923. Saer’s research indicated that on the Stanford-Binet scale, rural bilingual children were placed in a lower position than rural monolingual children. The study was performed with children at the age of 7, the most noteworthy outcome of his study was the statistic that showed the lower position of bilingual children on the scale increasing with each year from the age of 7 to 11. Saer explains this increase with an approach that was customary for that time, he stated that bilingual children must be undergoing a “mental confusion” (Saer, 1923, p.14).

In addition, Pintner (1932) compared results from non-language and language tests conducted by two groups in three schools, one English-speaking group and a non-English-speaking group. The non-English group was chosen on the likelihood that another language than English was being used in their home environment. Pintner administered language and non-language tests to the two groups and the results showed that monolinguals outperformed bilingual's in one school, but bilinguals performed better than monolinguals in another school and there was no difference between the groups in the third school. Thus, Pintner's results became inconsistent. What is more, bilingualism was generally viewed as an issue at the time of Pintner's research, as demonstrated in his study: "The present article deals with only one small part of the problem of language handicap or of the larger problem of bilingualism in general" (p. 235). Therefore, studies conducted before the 1960's typically discussed bilingualism as being a hindrance to children's language development.
Peal and Lambert (1962) published a break-through study on bilingualism that marked a beginning for a more positive outlook on children's bilingual development due to more suitable methodological approaches. The most fundamental aspect of Peal and Lambert’s study was the matching of bilingual and monolingual participants in terms of socioeconomic status, language proficiency, language experience, gender and age. This sort of thorough examination and assessment in a bilingual study had never been seen before. Therefore, a turning-point in bilingual studies was reached when the results of Peal and Lambert’s study revealed that the bilingual participants had outperformed monolinguals on several verbal and non-verbal intelligence measures whereas previous studies, such as Saer (1923) and Pintner's (1932) had displayed bilingualism as an obstacle to bilingual children's language development (Peal & Lambert, 1962).

Saer’s research was addressed by Peal and Lambert in their 1962’s article on the connection between bilingualism and intelligence along with other research such as Pintner’s “Pintner Language and Nonlanguage tests” (p.2). Regarding Pintner’s study, Peal and Lambert stated that “There was no control for socioeconomic class in this study and bilingualism was determined by looking at the child's name!” (Peal & Lambert, 1962, p.2). Fortunately, methods for assessing the bilingual degree have changed immensely since the early 20th century. Beginning with Peal and Lambert's study, the view on bilingualism shifted from being simplistic to the phenomenon being discussed and examined as a multidimensional experience using valid and reliable instruments.

2.2 Assessing Bilingualism

For assessing bilingualism, a valid approach that manages to cover all the many dimensions of bilingualism is needed. Yanping and Ping (2015) presented the importance of assessing participants second language proficiency in bilingual studies, age of second language acquisition, reasons for employing their second language and the amount of L2 usage. In addition, Yanping and Ping’s research branches out to the important factors of a bilingual experience but the question of how bilingual studies
might proceed in assessing all the important items arises. Obviously, an instrument is needed that can provide a distinct description of who is bilingual.

The Language and Social Background Questionnaire (LSBQ) is a good example of a reliable instrument for assessing the degree of bilingualism because it focuses on three important factors of bilingualism; socio-economic status, language proficiency in L1 and L2 as well as the reasons for using L1 and L2 (Anderson, Mak, Chahi & Bialystok, 2017). Anderson and his colleagues presented the LSBQ with the aim of verifying the questionnaire’s reliability for further research in bilingual studies. Furthermore, Anderson and colleagues obtained data from 386 female participants and 213 male participants who ranged in age from 16 to 44 years. Anderson and colleague's LSBQ has three main sections. The first one addresses participant's social background and aims at obtaining information such as participant's age, education, country of birth, immigration and parent's education. The second section focuses on participant's language background such as age of L1 and L2 acquisition, L1 and L2 proficiency, where they learned the language(s), how much they would rate their language(s) proficiency for speaking, reading, writing and understanding as well as the amount of L1 and L2 usage. The third section of the LSBQ aims at obtaining information regarding participant's language use during infancy, preschool age, primary school age and high school age as well as specific contexts of language use, that is, whether they are speaking the language(s) in school, work, home or in other contexts, and if they are speaking to friends, parents or siblings. In addition, the third sector proposes questions regarding participant's language switching in different contexts and which activities are being performed whilst using their language(s) such as reading or watching television. In accordance with the LSBQ, this paper focuses on presenting studies that assess participant's bilingual degree by examining socio-economic status, L1 and L2 proficiency and the amount of usage, that is, when the participants began speaking a second language and if they continue to do so daily.
2.3 Types of Bilinguals

In the latter part of the 20th century and the beginning of the 21st century, researchers began placing bilingual individuals into categories depending on various socio-cultural factors as well as participant's L1 and L2 proficiency. The assessment of an individual's bilingual degree became more complex than it had been before Peal and Lambert's landmark study in 1962 where they discussed the importance of examining individual's socioeconomic status, language proficiency, language experience, gender and age when assessing their bilingual degree. In the literature, Cummins's (2000) demonstrated ways to assess an individual's bilingual degree that became a guide to all subsequent bilingual studies. Thus, this chapter begins with a review regarding Cummins's (2000) threshold hypothesis that categorizes individuals into three levels depending on their degree of bilingualism. In addition, this chapter concludes with a discussion on early bilingualism, a term used for defining individuals that have successfully acquired two languages from birth (Luk, De Sa & Bialystok, 2011).

In the latter part of the 20th century, Cummins's presented the threshold hypothesis, his hypothesis was widely recognized and used as a device in bilingual studies (2000). The threshold hypothesis categorized bilingual individuals into three levels; balanced bilinguals, dominant bilinguals and the third level, semilinguals.

- **Balanced bilinguals** are regarded as individuals that have achieved high competence in both L1 and L2.
- **Dominant bilinguals** prefer one language over the other and therefore, develop more competence in one of their languages.
- **Semilinguals** are thought to be individuals that have lost significant amount of competence in both their L1 and L2.

Peal and Lambert (1962) were the first to introduce the term balanced bilinguals to the literature. Since Peal and Lambert's study (1962) and Cummins's (2000) threshold hypothesis, researchers have developed a more detailed interpretation of bilingualism whereas the age of L2 acquisition as well as the amount of L1 and L2 usage are important factors (Luk, De Sa & Bialystok, 2011). In addition, semilinguals is a term that is generally not used anymore in bilingual studies since balanced bilinguals;
bilingual individuals with equal or near-equal competence in two languages, are the ones being most often focused on. This paper will focus on this term in relation to early bilingualism.

*Early bilingualism (early bilinguals)* is a term used for describing bilingual individuals that have successfully acquired two languages from a very young age. In contemporary bilingual studies, age of second language acquisition, L2 proficiency and the duration of L2 exposure are factors that affect whether individuals are regarded as being bilingual. Moreover, Luk, De Sa and Bialystok (2011) put forth a study whereas 157 university students were placed into three groups depending on whether they were monolinguals, early bilinguals or late bilinguals. The categorization was based on the answers of a detailed language history questionnaire. Individuals were regarded as monolingual if they only used English for communicating and were fluent in the language. For the bilingual assessment, bilingual participants were asked to report the age of when they began using both languages daily. Furthermore, early bilinguals reported that they began actively speaking both languages before the age of 10 whereas late bilinguals stated that they began actively speaking both languages after the age of 10. The final sample consisted of 123 participants where 38 were monolingual, 43 were early bilinguals and 42 were late bilinguals. The categorization they used was that late bilingual participants began speaking two languages actively at the approximate age of 15 and early bilinguals began speaking two languages at the age of 5. Luk, De Sa and Bialystok compared the performance of the three groups on a flanker test (a test that requires participants to suppress unsuitable responses in a given context) and found that late bilinguals performed more like monolinguals whilst early bilinguals showed less interference on the flanker test than monolinguals. According to Luk, De Sa and Bialystok's findings, there is a connection between early onset age of bilingualism and reported findings in contemporary bilingual studies. In addition, they suggested that the onset age of active bilingualism (speaking two languages daily) represents the age of when bilingualism begins rather than the onset age of L2 acquisition.
2.4 Summary

This chapter aimed at presenting methods of bilingual assessment in the 20th century for contrasting those methods with the ones used in contemporary bilingual studies. To show the development in bilingual studies, first, past studies were reviewed and then, a reliable instrument that mirrors the assessment of bilingual individuals in contemporary studies. Thus, the LSBQ that focuses on three important aspects of bilingualism was discussed (Anderson, Mak, Chahi & Bialystok, 2017). In addition, the threshold hypothesis proposed by Cummins's (2000) was briefly reviewed because of the first threshold level, *balanced bilinguals* and its similarities to the contemporary idea involving *early bilinguals*. The idea being, that highly proficient bilingual individuals are individuals that become exposed to two languages from a very young age and continue to actively speak both languages daily. Moreover, in contemporary bilingual studies, the onset age is important as well as bilingual's reasons for using L2 and the type of context they prefer employing their L1 and L2 in. For this paper, the chapter's most important discussion was Luk and colleagues (2011) study whereas the age of commencement in using two languages daily was used for defining bilingualism rather than defining the phenomenon as beginning at the onset age of L2 acquisition. In accordance with Luk and colleagues research, this paper focuses on *early bilinguals* that use both their L1 and L2 daily thus, balanced bilinguals.
3 Executive Control

According to Friedman and Miyake (2017), executive controls are high-level cognitive processes that deal mainly with controlling lower-level processes that assist with goal-directed behavior. In addition, executive controls have often been associated with the frontal lobes of the brain that control various important cognitive abilities in human individuals. The three main executive controls are inhibition control, working memory and cognitive flexibility. Later this paper will explore how these relate to bilingualism but first, this chapter will introduce the framework that defines the concepts.

*Inhibition control* is the ability used to suppress irrelevant information from a distracting stimulus (*attention control*) as well as being the ability employed for controlling impulsive behavior. In the literature, *attention control* is likely the most studied executive control (Kapa & Colombo, 2013). Inhibition control assists individuals with ignoring irrelevant information as well as inhibit persuasive internal desires. (Diamond, 2013). Therefore, this is a highly important ability for individual's everyday responsibilities such as focusing on a task and controlling unsuitable behavior.

*Working memory* deals with a small amount of information that can be stored in the mind and then used for implementing various cognitive tasks. Individual's working memory is immensely important for abilities such as planning, reasoning, problem solving and comprehension (Cowan, 2013). For instance, working memory assists individuals in comprehending sentences that they hear. If an individual hears the sentence *Amanda only does her grocery shopping in the store that is conveniently located right across her house*, for the sentence to make sense, the individual must store information on the beginning of the sentence and then recall that Amanda is the one being talked about. Also, the individual must retain the verb *does* until the speaker informs the individual of what it is that Amanda is doing in the given sentence as well as retaining the information of *conveniently located* until the individual is told what the item is that happens to be conveniently located for Amanda's benefits. Thus, working
memory is crucial for various tasks such as holding information in mind for recounting it later and connecting old information to new knowledge.

*Cognitive flexibility* is often referred to as *set-shifting*; the ability to switch between tasks. In addition, the fundamental aspect of cognitive flexibility involves the ability to change perspectives (Diamond, 2013). The ability to change perspectives will be discussed in more detail in chapter 4, as bilingual's ability to switch from one language to another or, to use the linguistic term; *code-switching*. As the third primary executive control, cognitive flexibility is often talked about in accordance with inhibition control and working memory. In addition, cognitive flexibility is the ability to switch between mental tasks and it builds on the other two primary executive controls. According to Diamond (2013), to switch between mental tasks or change perspectives, individual's must first inhibit previous perspectives and load into working memory for activating a different perspective.

Inhibition control that assist the brain with suppressing irrelevant information from a distracting stimulus (*attention control*) has received the most focus in the literature. Furthermore, it is not uncommon to think about executive controls as a one whole because executive controls are often regarded as devices that function together (Kroll, Bobb & Hoshino, 2014). Miyake et al., (2000) presented an analysis for three different executive controls in terms of unity and diversity, their analysis gained a lot of recognition and acceptance. At the time, their analysis focused on shifting (*cognitive flexibility*), updating (*working memory*) and inhibition (*attention control*) and their roles as executive controls. More exactly, their analysis focused on the difference between executive controls that deal with shifting between mental tasks, updating and monitoring of the working memory and the inhibition of prepotent responses. One of their findings demonstrated that the three targeted executive controls, shifting, updating and inhibition were distinctly different yet-, moderately correlated controls.

In 2012, Miyake and Friedman published a report where they presented information on the same field of topic as their previously discussed study was based on in the year 2000. Miyake and Friedman (2012) discuss the term ‘task-impurity’ in their
report which implies that arguably the most problematic aspect of executive control
tasks is that any targeted executive control must be fixed within a specific task context.
For an example, Miyake and Friedman demonstrated how the Stroop task requires
participants to name the color of ink wherein color words are written (for an example, RED written in green ink). The problem with executive control tasks, for an example, the Stroop task, is that it might require the processing of non-executive control aptitudes as in color processing and articulation speed. Therefore, it might become difficult to distinctively measure the targeted executive control because of non-executive control variables that also become involved in the tasks.

Four major conclusions became established in Miyake and Friedman’s (2012) report. The first conclusion derives from a unity/diversity theory, more exactly, that different executive controls might be tapping into a common underlying ability which suggests a certain unity between them. The second conclusion proposes that there might be a substantial genetic contribution to executive control processes. Furthermore, Miyake and Friedman’s third conclusion demonstrated that distinctively cognitive measures of executive control might predict individual differences such as societal behaviors (for an example, individual’s faithfulness) and the fourth conclusion implied that individual’s executive control showed certain stability throughout their development. Although their study displayed that individual's executive control remains relatively stable throughout development, the idea does not suggest that executive control abilities do not change to some extent.

This chapter aimed at discussing the three primary executive controls in a
general manner. Three primary executive controls, Inhibition control, working memory
and cognitive flexibility contribute to higher executive processes in human individuals
such as planning and problem solving (Diamond, 2013). As the studies in the chapter indicated, executive controls often correlate with each other to some extent.
Undoubtedly, executive controls are important processes that play a significant role in
people's everyday lives.
4 Bilingualism and Executive Control

The topic of whether bilingualism affects executive control has been and remains immensely controversial (Paap, Johnson & Sawi, 2015). However, recent studies in the literature indicate that bilingual individuals might exhibit advantages involving increased inhibition control (especially attention control), working memory and cognitive flexibility (set-shifting). These bilingual advantages have been linked to executive control in the bilingual brain. Additionally, recent research has displayed how the process of knowing two languages develops executive control and hence, may contribute to an increase in cognitive skills. More importantly, studies have shown that cognitive development involving specific bilingual advantages might commence before any speech production has begun. With a focus on the benefits from dual-language exposure from birth, this chapter aims at presenting data on the links between bilingual children’s dual-language exposure and early bilingual adult’s cognitive development respectively. Thus, countless studies have supported the idea that the usage of two or more languages might benefit executive control in the bilingual brain, resulting in various bilingual advantages. For example, children's second language acquisition supports and embraces their cognitive development, as expressed in Bialystok, Craik, Green and Gollan's (2009) article:

“The most striking feature of a young child’s acquisition of language is the extraordinary ease with which the process appears to progress. Perhaps more remarkable than this achievement, therefore, is that this facility for learning a complex symbolic system is not diminished when the child faces the task of learning two of them. Bilingual language acquisition is as effortless, efficient, and successful as monolingual acquisition. It is now clear that language acquisition is not a simple matter of biological unfolding, as some had previously believed, but rather a process that is finely tuned to features of the environmental input, the child’s attentional and perceptual abilities, and the development of cognitive and conceptual competencies” (p. 90).

Since children appear to acquire languages effortlessly, it is remarkable to think about the complex executive control being exercised by young children's bilingual language acquisition. Moreover, one of the main reasons for the growing interest in this aspect of
bilingual literature might derive from the fact that general executive controls play a major role in people’s daily lives (Miyake & Friedman, 2012). Therefore, scholars constantly aim at gaining more knowledge from the connection between being bilingual and the development of executive control in the bilingual brain.

The Dimensional Change Card Sort task and the Attention Network Task are frequently employed tasks in bilingual studies for measuring executive control in bilingual and monolingual participants. Due the possibility that there might be some unity amongst executive controls, there is a need for more definite tools for examining the relationship between bilingualism and its role on executive control. Also, as mentioned previously in this paper, executive control tasks may require processing of non-executive control abilities such as color processing for successfully executing the Stroop task (Miyake & Friedman, 2012). However, this chapter will present results from executive control tasks that have reported consistent findings throughout the bilingual literature. The DCCS task has been widely used for measuring cognitive flexibility and the ANT task for inhibition control, the two major executive controls that will be of most focus in the last two chapters of this essay, thus the two tasks will be explained in more details below.

The Attention Network Task (ANT) has typically been employed in studies examining the connections between bilingualism and executive control in bilingual children (Rueda, Fan, McCandliss, Halparin, Gruber, Lercari & Posner, 2004). Whilst performing the ANT task, participants must control their attention from distracting stimuli. More exactly, participants are supposed to “feed” the correct fish (out of five options) by suggesting the direction it faces by pressing a key. In congruent tasks, the four distracting fishes point in the same direction (no inhibition control required) whilst in incongruent tasks, the fishes point in opposite directions. According to various findings, bilingual children outperform monolingual children on executive control tasks when inhibition controls are required (Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008; Yoshida, Tran, Benitez & Kuwabara, 2011; Kapa & Colombo, 2013; Arredondo, Hu, Satterfield & Kovelman, 2016). More importantly, some studies suggest that with early and intensive bilingual development, early bilingual children
might acquire more developed executive control than bilingual children that use their L2 less or acquire a second language later in life.

*The Dimensional Change Card Sort Task* (DCCS) has often been used in studies examining executive control in bilingual children. Generally, the DCCS task requires participants to sort a set of cards by one dimension and then to re-sort them by a different dimension. For an example, often when the experiment is conducted with young children, they are first presented with two boxes that are marked with different target stimuli and a set of cards. The target stimuli might be a red square and a blue circle whereas the set of cards contain either a red circle or a blue square. For the first sorting dimension, the children might be asked to sort the cards into the correct box by color (cards containing a red circle go into a box marked with a red square). The children are then asked to re-sort the cards by shape, therefore expected to place the cards in the opposite box. Typically, preschool aged children continue to sort the cards by the first dimension where they continue to put cards with red squares in the box marked with a red circle (Bialystok & Martin, 2004). Thus, the DCCS task is frequently used in bilingual studies for examining bilingual children's cognitive flexibility.

Studies investigating the roles of executive control in the bilingual brain have been ongoing actively for a long time. However, studies examining the effects of bilingualism on executive control from early development began approximately two decades ago (Garon, Bryson & Smith, 2008). According to most studies conducted on bilingualism in the 21st century, bilingual individuals might benefit from certain bilingual advantages, especially controls involving inhibition processes such as more developed attention control. This paper will go further into detail regarding the main theories for the appearance of these bilingual advantages in the next chapter. For now, the focus will be on presenting the bilingual advantages in a general manner as well as studies that have been conducted on young bilinguals and monolinguals on various tasks requiring the use of executive control. Although it is not easy to simply state the reasons for why bilingual individuals develop such increased executive control, especially highly proficient bilingual children that have been exposed to two languages since birth, evidence implying that bilingual children inhibit more increased executive
control than monolingual children have been reported several times throughout the literature.

4.1 Bilingualism and Inhibition Control

Studies have suggested that bilingual advantages in terms of inhibition processes might begin in bilingual infant's executive control development before any speech-production has taken place. Such evidence was found in a study examining a group of 2-year old bilingual and monolingual participants (Poulin-Dubois, Blaye, Coutya & Bialystok, 2011). The main goal of the study was to employ a series of both delay and conflict tasks that required either the suppression of motor responses or attention from fluctuating to a distracting stimulus. Poulin-Dubois and colleagues administered a version of the Stroop task but Stroop tasks in general, are often employed for measuring response time, cognitive flexibility and attention control. Their version of the task involved identifying a small image of a fruit correctly that had been placed in a larger image of a different fruit. Since one of the results of their study was that the two language groups differed only on a Stroop task, they concluded that bilingualism influence on executive control might first be expressed in conflict inhibition (an ability needed for controlling conflicting attentional demands). In addition, their findings support the idea that bilingual children might possess more inhibition control than their monolingual peers.

Other studies examining executive control in bilingual infants have suggested that domain-general executive controls might commence earlier than previously expected in the literature. Brito and Barr (2012) assigned 18-month old bilingual and monolingual infants to two conditions, the generalization condition where the experimenter performed three actions with a duck puppet and a baseline condition where no action was performed. After a 30-minute pause, the infants were given a novel puppet and encouraged to interact with it. The results from Brito and Barr’s experiment illustrated that bilingual infants outperformed monolingual infants in their ability to execute the observed actions to the novel puppet. In addition, Brito and Barr’s findings
suggest that bilingual advantages might occur well before any speech production occurs. There might be several explanations for the results presented in Brito and Barr's findings. The bilingual infants might have successfully focused on the experimenter's actions (the three actions performed in the generalized condition) whilst ignoring misleading cues, or another reason for these findings could be that bilingual infants begin forming *hierarchical mental representations* (Brito & Barr, 2012) earlier than monolingual infants. For infants to successfully remember the cues and be able to generalize amidst them, they must encode the details of the cue presented to them in a hierarchical manner and thus, create memories that are connected by contributing factors as well as logical and temporal relationships (Brito & Barr, 2012). The bilingual advantage found in Brito and Barr's study might therefore have appeared because bilingual infants must connect words from two different languages and make connections at an abstract level between the two words and their meaning.

The studies discussed above demonstrate that bilingual advantages have been found for pre-verbal bilingual infants on a domain-general level but more specifically, inhibition control. Bilingual infants might express less cognitive advantages than preschool bilinguals because of lack in expressive language usage. Nevertheless, bilingual infants must organize and inhibit the languages they hear, which in turn, might influence executive controls such as their inhibition control, especially inhibiting attention from fluctuating to a distracting stimulus.

Three recent studies presented corresponding results from bilingual and monolingual children's performance on executive control tasks requiring the use of *inhibition*, or more precisely *attention control*. Yoshida and colleagues (2011) conducted a study with 40 children at the age of three as participants. In their study, they found that bilingual children performed better than monolingual children on a control task requiring them to pick a labeled object when it was labeled with a known adjective from a set of two objects. Additionally, Yoshida and colleagues (2011) found that bilingual children outperformed monolingual children in a non-linguistic ANT task.

Similarly, Kapa and Colombo (2013) conducted a study where they administered the ANT task to early Spanish-English bilingual children that had commenced in
speaking both languages by the age of three, later Spanish-English bilingual children that began speaking both languages after the age of three and monolingual English speakers. The results from their study demonstrated that early Spanish-English bilingual children responded faster on the ANT task than English monolingual children and later Spanish-English bilingual children. Therefore, their results supported previously reported evidence demonstrating an increase in executive control for bilingual children that had been exposed to two languages since birth.

In addition, Arredondo and colleagues (2016) aimed at examining the effects of bilingualism on bilingual children’s non-verbal attention control and its function in the bilateral prefrontal cortex. Participants were matched on age, intelligence quotient (IQ), English language proficiency and parental education. Similarly, to Kapa and Colombo’s (2013) conclusion, Arredondo and colleagues found that early bilingualism conveys significant changes to the functional organization of children's prefrontal cortex for attentional control. The three studies reviewed above found support for a similar conclusion; that early bilingualism contributes greatly to the development of attention control in early bilingual children.

In Carlson and Meltzoff’s (2008) study, nine executive control tasks were administered to three groups of kindergarten children. 12 bilingual children that had dual-language exposure in Spanish and English from birth were placed in the bilingual group. A group for immersion children consisted of 21 kindergarten children attending a language immersion school where they received English lessons for half of the school-day, 13 of them received Spanish lessons and 8 received Japanese lessons for the other half of the day. 17 English monolingual kindergarten children were placed in a control group. Differences in vocabulary, age and parent’s education and income levels were controlled in their study and bilingual advantages were found in interference suppression and instances requiring memory but not response inhibition (also known as impulse control). More exactly, this supports the bilingual advantage theory regarding the ability to suppress irrelevant information from a distracting stimulus but not response inhibition which is the ability to suppress unsuitable behavior.

The four studies reviewed above had early bilingual children as participants, with Kapa and Colombo’s (2013) study assessing both early and late bilingual children.
as participants. All the studies found a bilingual advantage for bilingual children's attention control. Additionally, Kapa and Colombo (2013) found that early bilingual children performed better on an ANT task than the late bilingual group of children and Carlson and Meltzoff (2008) did find a bilingual advantage in interference suppression and working memory on the DCCS task but not in response inhibition. More research on bilingual children's inhibition control is needed, or rather, which sub-controls are the ones being mostly affected. According to the studies presented in this chapter, bilingual children outperform monolingual children on executive control tasks that require the use of attention control.

4.2 Bilingualism and Working Memory

Not as much research has been conducted specifically on examining the consequences of bilingualism on bilingual children’s working memory as has been done with inhibition. In the literature, it is not firmly concluded that there is a bilingual working memory advantage (Engel de Abreu, 2011). Nevertheless, several findings have suggested that bilingual individual's working memory might benefit from their knowledge of two languages (Brito & Barr, 2012; Morales, Calvo & Bialystok, 2013; Blom, Küntay, Messer, Verhagen & Leseman, 2014).

Findings presented from studies such as Morales, Calvo and Bialystok’s (2013) suggest that bilingual children outperform monolingual children on working memory tasks. Morales and colleagues (2013) reported findings from two studies whereas they compared the performances of 5-year old bilingual and monolingual children on tasks requiring working memory control. In the first study, 29 children were monolingual, and 27 children were early bilinguals that used both languages daily. For the second study, the same 56 bilingual and monolingual children participated along with a new group of 7-year old early bilingual and monolingual children (35 bilingual and 34 monolingual children). Early bilingual children (both languages used daily) from both studies outperformed monolingual children on working memory tasks. In addition, the results from Morales's and colleagues (2013) study consist with Miyake and Friedman's
(2012) discussion on unity and diversity in executive controls. The reason lies in the outcome of the participant's performance in Morales's and colleagues (2013) study where the bilingual's working memory had to be used to recall position and order information whilst ignoring interference from competing positions in a wrong sequence (inhibition control).

However, studies have reported findings in bilingual children's working memory development that go beyond inhibition control (Blom, Küntay, Messer, Verhagen & Leseman, 2014). Blom and colleague's (2014) study aimed at measuring Turkish-Dutch bilingual children's visuospatial and verbal working memory. The participants in their bilingual group were 5 and 6-year-old early bilinguals that spoke one language at home and a different language in other settings such as daycare, school or preschool. In the study, Turkish-Dutch bilingual children revealed cognitive advantages in visuospatial and working memory tasks. Their findings were consisted with the hypothesis that bilingual children who are exposed to both languages in the same environment may display more cognitive advantages due to their experience of managing interference from both languages.

In conclusion, the studies discussed above presented results suggesting that early bilingual children performed better than monolingual children on tasks measuring working memory control, but the same tasks also required the participants to employ their inhibition control. Findings on bilingual's working memory development rely a lot on the type of tasks that are being employed in each study with tasks that require the use of attention control yielding results of more working memory capacity for bilinguals than monolinguals (O. Adesope, Lavin, Thompson & Ungerleider, 2010). Therefore, findings on early bilingual children's working memory are inconsistent and need more research before any distinct conclusions can be made.

4.3 Bilingualism and Cognitive Flexibility

Cognitive flexibility is the third major executive control component in focus and this ability to switch between tasks is often measured in unison with one or both other two major executive controls (inhibition and working memory). For an instance, the
DCCS measures inhibition control (participants ignore previous dimension) and cognitive flexibility (participants shift their attention towards the new dimension) (Bialystok & Martin, 2004). Individuals that are unable to sufficiently switch from one dimension to another, as in, do not manage to inhibit previously executed responses, are believed to have lower cognitive flexibility than individuals that sufficiently manage to suppress previously employed responses. In addition, the ability to switch between tasks has been linked to proficiency in problem-solving which requires other executive controls as well, such as inhibition control for suppressing unsuitable actions (O. Adesope, Lavin, Thompson & Ungerleider, 2010). Therefore, the rest of this paper will discuss cognitive flexibility in accordance with inhibition and attention control. Due to inconsistency in research outcomes of studies on early bilingual's working memory, more focus will be given to the other two primary executive controls, inhibition and cognitive flexibility.

4.4 Executive Control and Bilingual Code-Switching

Primarily, studies have concluded that bilingual individuals might benefit largely from the practice of switching between two or more languages (Bialystok, Craik, Klein & Viswanathan, 2004). Usually, bilingual individuals employ one language at a time and without much apparent effort, employ a different language when needed or wanted. This constant transfer from one language to another has generally been termed as code-switching. Although the term code-switching has mainly been used for bilingual individuals that have had plenty of practice in speaking multiple languages, recent studies have demonstrated that bilingual infants exposed to two or more languages might also exhibit bilingual advantages because of code-switching activities that occur around them daily (Kovács & Mehler, 2009; Poulin-Dubois, Blaye, Coutya & Bialystok, 2011). In addition, studies experimenting with various executive control tasks, especially task-switching ones, have suggested that bilingualism influences executive control through code-switching which can be transferred into non-linguistic executive control tasks. According to Hartanto and Yang (2016): “Bilinguals are unique in their practice of flexible language-switching between two or more languages (p. 10).”
In the literature, researchers have pointed out that by keeping two languages in mind and suppressing interference from one language whilst employing a different language, bilingual individual's exercise executive control in ways that will be further discussed in following paragraphs.

A study conducted by Kovács and Mehler suggests that a bilingual individual’s mechanism for processing two separate linguistic representations might already be employed before any commencement of speech production (2009). The participants in their study were 7-month old pre-verbal monolinguals and bilinguals that had been exposed to two languages from birth. The participants were matched for age, gender and their parent’s socioeconomic status. In the study, infants were presented with a verbal cue followed by a visual reward (a toy). Bilingual and monolingual infants were equally quick at learning that a verbal cue predicted the location of the visual reward in the first part of the experiment. In the second part, the rules were changed whereas the visual reward appeared on the opposite side of the screen. Thus, to achieve the reward, the infants had to overcome their previously learned habit by employing their executive controls. Kovács and Mehler found that infants raised in bilingual households were quicker at switching responses than infants raised in monolingual households. The results from Kovács and Mehler’s study indicate that pre-verbal exposure to two languages develops executive control, even before any speech production takes place.

Past research on bilingualism displayed the phenomenon as an issue that might confuse language learners because of the simultaneous activation of two languages in the brain. Costa, Hernández and Sebastián-Gallés (2008) conducted a study regarding bilingual's attention control that contrasts this former belief. The main purpose of their study was to find an answer to whether bilingual individuals inhibited certain attention or linguistic mechanisms that prevents them from mixing their L1 and L2 whilst using either one of their languages. To find an answer, they compared the performance from an ANT task in two groups consisting of 100 participants each (Costa, Hernández & Sebastián-Gallés, 2008). One group consisted of 100 Spanish monolinguals with the median age of 22 years and the other group consisted of 100 Catalan-Spanish bilinguals with the median age of 22 years. The bilingual participants had been exposed to both
languages from a very early age. The results of their study presented evidence for the positive effects of bilingualism on bilingual individuals attention control. Therefore, bilingual individuals may benefit rather than be hindered by the simultaneous activation of two languages in mind. Studies have also presented findings for the positive effects of bilingualism on inhibition control in early bilingual children (Yoshida, Tran, Benitez & Kuwabara, 2011; Kapa & Colombo, 2013; Arredondo, Hu, Satterfield & Kovelman, 2016). Thus, much evidence has surfaced suggesting that simultaneous activation of two languages in the brain and the constant switching between them (inhibiting one language whilst using the other language) may exercise executive controls that deal with attention control and cognitive flexibility.

Bilingual individuals show certain measures of activity in both languages and some interaction between the two languages, even when they only need to use one of their languages (Bialystok, Craik & Luk, 2012). Furthermore, a study was conducted by Martin, Dering, Thomas and Thierry (2009) on bilingual individuals in their early twenties that had acquired two languages parallelly from birth that supported a theory regarding joint-activation of languages in early bilinguals. The theory being that bilingual individuals must inhibit a certain bilingual advantage in executive control from an ability to resolve conflict from containing languages that are simultaneously active. The key question that Martin et al., aimed at answering in their study is whether the two languages in a bilingual individual’s mind are always simultaneously active or if one of the languages becomes inactive due to the usage of the other language. They examined results from low-level, non-linguistic letter-counting tasks done by highly proficient bilingual’s in their early twenties. The results demonstrated that lexical and semantic accesses are both automatic in bilinguals within the first 400 milliseconds after the presentation of a word. In addition, the results from their study also indicated that working memory is constrained by attention control. Therefore, words from the language being used are the ones being applied. The results of their study support the theories regarding bilingualism and its influence on attention control and working memory. The two executive controls appear to be working together in the sense that attention control supports the bilingual mind in employing one language at a time from the working memory database.
Moreover, increased attention control has been linked to bilinguals use of two languages, more specifically, their ability to operate one language at a time even though they possess equal or near-equal proficiency in more than one language. Therefore, by speaking one of their languages at any given moment, bilingual individuals almost unconsciously ignore the language that is not being used (Bialystok & Martin, 2004). In bilingual individuals, the ability to ignore misleading cues is constantly being exercised because of their ability to provide attention to one language whilst hindering distraction from their other language, this advantage has been found in bilingual adults (Costa, Hernández & Sebastián-Gallés, 2008), bilingual children (Martin & Bialystok, 2008) and bilingual infants (Brito & Barr, 2012). Therefore, the effects of bilingualism on individual’s attention control might first commence before any speech production has begun and most likely continue developing with active bilingualism.

Bilingual individuals may develop their cognitive shifting controls since their language-switching practice can also be applied to non-linguistic shifting tasks (Prior & MacWhinney, 2010; Mehrani & Zabihi, 2017). Mehrani and Zabihi (2017) found that early bilingual children displayed a certain bilingual advantage in shifting controls (cognitive flexibility) and inhibition control but no specific bilingual advantage was found for the participant's working memory. Moreover, 31 Persian monolingual children and 36 Persian-Turkish early bilingual children participated in the study. The participants completed a Persian language competence test, DCCS task, Simon task and a Digit recall task (for assessing their working memory). One of the findings was that early Persian-Turkish bilingual children outperformed monolingual children on the DCCS task, thus, indicating that the bilingual experience of code-switching influences cognitive shifting-controls.

In Prior and MacWhinney’s (2010) study, 44 bilingual and 44 monolingual participants aged 18 to 19 performed on non-linguistic task-switch paradigms. The bilingual participants had all learned English and another different language before the age of 6 as well as used both languages actively ever since. The results of their study indicated that the practice of switching between languages correlates with specific bilingual advantages in shifting between mental tasks (cognitive flexibility). In addition, Prior and MacWhinney (2010) concluded that shifting and inhibition might correlate
with each other. These results are in correlation with previously discussed findings on early bilingual children's and early bilingual young adult's inhibition control and cognitive flexibility.

Studies presented in this chapter aimed at displaying in what way the bilingual experience of maintaining two languages in mind and the constant switching between two languages enhances executive controls, especially inhibition (attention control) and cognitive flexibility. For working memory, findings have been inconsistent throughout the literature, therefore, no distinct conclusions can be made of how bilingualism might influence working memory. The first study presented in this chapter suggests that bilingualism might influence important executive controls in pre-verbal bilingual infants that are exposed to two languages (Kovács & Mehler, 2009). In addition, this chapter aimed at presenting findings on the consequences of joint-activation of two languages and code-switching for early bilingual children and early bilingual adults. The findings suggest that the constant switching between two languages may result in more developed inhibition control and an enhanced ability for shifting between mental tasks (Costa, Hernández & Sebastián-Gallés, 2008; Martin, Dering, Thomas & Thierry, 2009; Prior & MacWhinney, 2010; Yoshida, Tran, Benitez & Kuwabara, 2011; Kapa & Colombo, 2013; Arredondo, Hu, Satterfield & Kovelman, 2016; Mehrani & Zabihi, 2017). The bilingual experience influences executive controls that might assist with goal-directed performances such as academic achievement, which will be discussed in more detail in the next chapter.
5 Executive Control and Bilingual Academic Achievement

Executive controls are important devices for successful academic achievement since they are constantly being implemented in a learning situation. According to Yadava and Yadava (2018), "Academic achievement represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in school, college, and university" (p. 158). In addition, executive controls are abilities that individuals employ whenever they need to organize, concentrate or solve problems. In a typical academic environment, whether it is a math equation or an attempt to keep focus on a lecture, individuals are often faced with tasks that require them to use their executive controls. As mentioned previously, executive controls assist with goal-directed behavior which is also the key to completing most academic tasks. Therefore, in contemporary literature, bilingualism is expected to influence academic achievement to some extent. However, the bilingual experience and in what ways it affects academic achievement is an active field of research with no definite answers.

In general, studies have found that executive controls influence individual's academic achievement. Yadava and Yadava (2018) found that a dimension of executive controls were predictors of academic achievement. For the study, a group of 100 individuals from grades 6-8 were selected based on availability. Yadava and Yadava administered self-regulation tests to participants for assessing their executive controls in terms of organization skills, motivation, strategic planning, empathy and impulse control along with another test for assessing their metacognitive awareness. Results from their study demonstrated a high correlation between executive controls and academic achievement, especially in motivation and organization. Thus, supporting other studies that have found a similar connection between executive controls and academic achievement (Best, Miller & Naglieri, 2011; Cowan, 2013).

A much-researched concept in the bilingual literature is the lexical retrieval process in young bilingual individuals. The fact that it takes longer to produce words in a second language than in a primary language is one of the most fundamental reasons for the growing interest in bilingual children's lexical retrieval process (Chen & Leung, 1989). Moreover, findings from studies whereas bilingual and monolingual children's
performances in tasks involving lexical retrieval suggest that monolingual children outperform bilingual children in such tasks (Bialystok, Barac, Blaye & Poulin-Dubois, 2010). In Bialystok, Barac, Blaye and Poulin-Dubois's study, 37 monolingual French-speaking children in France, 69 monolingual English-speaking children in Canada and 56 bilingual children in Canada were assessed on word-mapping and executive control. The results of the study indicate that bilingual children might experience disadvantages in linguistic processing, possibly due to the bilingual experience of maintaining two languages in mind as well as constantly shifting between them. Nevertheless, the study found a bilingual advantage for various executive control components, including cognitive flexibility. Thus, although bilingual children seem to be behind in terms of lexical processing, various studies have suggested that bilingual's children's executive controls development is greatly influenced by bilingualism which in turn, may assist with their academic achievement.

To summarize and demonstrate a connection between bilingualism and academic achievement; bilingualism trains executive control by the maintenance of two languages in mind and the constant practice of switching between the two languages (Costa, Hernández & Sebastián-Gallés, 2008; Martin, Dering, Thomas & Thierry, 2009; Kovács & Mehler, 2009; Bialystok, Craik & Luk, 2012). Inhibition control, working memory and cognitive flexibility are three primary executive controls that assist with other sub-controls such as attention from fluctuating to a distracting stimulus and the ability to shift between mental tasks (Diamond, 2013). Studies comparing the performance of early bilinguals and monolinguals have found that early bilinguals outperform monolinguals on tasks requiring the use of inhibition control (Poulin-Dubois, Blaye, Coutya & Bialystok, 2011; Yoshida, Tran, Benitez & Kuwabara, 2011; Kapa & Colombo, 2013; Arredondo, Hu, Satterfield, & Kovelman, 2016). In addition, early bilinguals might develop set-shifting abilities because of their constant language-switching practice (Prior & MacWhinney, 2010; Mehrani & Zabihi, 2017). Executive controls are high-level processes that assist with organization, concentration and problem-solving, all in which are important abilities for successful academic achievement (Yadava & Yadava, 2018). Therefore, it seems reasonable to expect that bilingualism influences goal-directed performances such as academic achievement to some extent.
5 Conclusion

This paper focused at reviewing several studies that compared the performance of early bilinguals and monolinguals on various executive control tasks and discussing their findings for a possible idea regarding the consequences of early bilingual's cognitive development. In this paper, bilingualism was defined as beginning at the onset of active language use in both L1 and L2 with a focus on early bilingual's cognitive development. Before reviewing the studies on bilingualism, three primary executive controls were introduced, inhibition control and its sub-processes such as impulse control and attention control and two other major executive controls, working memory and cognitive flexibility. Due to inconsistency in research outcomes on working memory's influence on tasks requiring the use of executive control, this paper focused mainly on presenting it as a possible influencer with attention control playing the biggest role. Cognitive flexibility, or more exactly, the ability to switch between tasks has gained a lot of attention in the literature because of its apparent role in the bilingual experience. After reviewing and discussing studies that compared the performances of early bilinguals and monolinguals on tasks demanding the use of executive control, the reasons behind these outcomes and their connection to the bilingual experience was discussed. Bilingual's maintain two languages in mind but only employ one of them at a time. This practice, often referred to as the bilingual experience throughout this paper, is believed to influence executive control. Thus, this paper discussed how bilinguals, with the focus on early bilinguals, inhibit one language and control their attention from the other language that is not being used. The bilingual experience also involves the practice of switching from one language to another which this paper often referred to as code-switching. This constant switching between two languages influences non-linguistic task-switching as well and possibly providing a lot of practice for cognitive flexibility. Therefore, the bilingual experience is believed to influence executive control in the bilingual mind. The final chapter aimed at bringing together the overall research outcomes reviewed in the paper for a better understanding on their influence on goal-directed performances. As mentioned in this paper, executive controls impact goal-directed performances such as academic achievement. Thus, a brief analysis on the possible link between bilingualism and academic achievement as a goal-directed
performance was the final discussion of this paper. One of the main purposes for the final discussion was to show the need for more research on this topic. Nevertheless, based on the research reviewed, the suggestion is that due to early bilingual's performance on tasks requiring the use of executive control and executive controls influence on goal-directed performances, it seems realistic to think that the bilingual experience influences goal-directed performances such as academic achievement to some extent.
References


