SOCIO-COGNITIVE ADVANTAGES IN EARLY SECOND LANGUAGE LEARNERS AND YOUNG BILINGUALS

by

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Abstract

Early bilingual experience has been shown to be beneficial to general cognitive skills. Young bilinguals have displayed advantages in cognitive control measures, demonstrating superior abilities in control over attention and switching between rules (Bialystok & Martin, 2004). Young bilinguals have also revealed a less egocentric approach in solving perspective taking problems (Fan et al., 2015) and enhanced fluency and flexibility of thinking during creative production (Leikin et al., 2014).

This thesis explored the possibility that learning a second language (L2) at school in the first year of formal education could trigger the advantages shown by children who acquire a L2 in natural contexts. The present work also investigated two main accounts, that is the socio-pragmatic and the Executive Functions account, for a young multilingual perspective taking advantage in referential communication.

Chapter 2 and 3 present a longitudinal study conducted on monolingual children aged 4-5 from Reception classes in Primary schools in England. Three groups of monolingual children with different amount of exposure to a second language performed tasks of attentional control, cognitive flexibility, conversational perspective taking and divergent thinking. Testing took place in the first few months of the school year and 24 weeks later. Differences between the groups were found at the second (but not first) testing point. The two groups of children learning a second language at school outperformed the control group in the tasks of cognitive flexibility and referential perspective-taking. The group with the greatest amount of L2 exposure showed an additional superiority in cognitive flexibility as compared to the group with a limited L2 exposure and recorded higher scores in creative fluency and flexibility as compared to the control group not receiving any L2 education. This suggests that early L2 learning in formal

settings can enhance cognitive flexibility and referential perspective taking, even if children receive a minimal amount of exposure. However, the amount of L2 exposure increases cognitive flexibility. Results also showed that early L2 learning can enhance creative fluency and creative flexibility, provided that children are exposed to the new language for a considerable amount of time.

Chapter 4 presents a cross-sectional study that compared young multilinguals and their monolingual peers in two versions (a social and a non-social version) of a referential perspective taking task. Measures of inhibitory control and a task of emotion comprehension were also administered. Multilingual children outperformed monolingual children in both the social and the non-social condition of the communication experiment. Multilinguals demonstrated superior inhibitory control in the inhibition tasks, but no difference was recorded between multilinguals' and monolinguals' performances in the TEC. Although inhibitory control and emotion understanding were positively related with children's performance in the communication tasks, neither inhibition nor emotion comprehension could account for multilinguals' superior performance in the task. We speculated that a third factor, that is metalinguistic awareness, could be crucial for multilinguals' superiority in referential perspective taking.

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CHAPTER 1
GENERAL INTRODUCTION

1.1 Introduction

Languages open doors. With this thought in mind parents might be prompted to put their children very early on the path of second language learning. Parents and educators might also be allured by articles on national papers boldly claiming that "learning a second language increases brainpower" (Griffiths, 2016). Indeed, there is scientific evidence that speaking more than one language from a very early age is beneficial to cognitive development (see review in Barac et al., 2014). However, whether the benefits of being raised in bilingual households extend to young learners of second language at school is still unclear. Moreover, the advantages of bilingualism on cognition are controversial among the academic community. Introducing second language learning at very early stages of formal education might be perceived as pointless by head teachers and policymakers, especially in English-speaking countries where speakers already have a lingua franca as passe-partout.

In England, foreign language learning is scarce across all levels of education, and primary schools are not an exception in this desolate landscape (Long et al., 2020). Second language (L2) learning at primary level became mandatory only in 2014 (Long et al., 2020), relatively recently if compared to the rest of Europe, where L2 learning in primary schools was made a statutory requirement between 1984 and 2007 (European Commission, 2008). At present, the National Curriculum in England compels primary schools to teach a second language (either modern or ancient) in Key Stage 2 (i.e., from Year 3 to Year 6 - pupils over 7 years of age; Long et al., 2020). However, in many schools the L2 is considered a marginal subject, with most schools allocating less than one hour a week to it (Office for Standards in Education, 2016). A recent report by the British Council (Tinsley & Dolezal, 2018) revealed

that, despite schools formally scheduling time to weekly L2 classes, the second language might be taught only occasionally. As a result, at the end of primary school, children's skills in the L2 do not fully meet the levels set by the National Curriculum (Tinsley & Dolezal, 2018). Finding curriculum time for L2 teaching is one of the major challenges identified by primary schools, especially in upper grades where the focus is on pupils' preparation for the Standard Assessment Tests in Maths and English (Tinsley & Dolezal, 2018).

In the last decade, many European countries have increased the time dedicated to language learning in compulsory education by lowering the age at which a second language is learnt (European Commission, 2017). Primary school children in Scotland, for example, are entitled to be taught a modern language from the first year of school (Long et al., 2020). In some areas of Belgium and Spain, L2 learning is compulsory for children as young as three years of age (European Commission, 2017). However, the expectations regarding L2 proficiency levels during early years of education need to be realistically calibrated. A study conducted in the Netherlands on children who started learning English as a foreign language (EFL) at the age of four found that, after receiving three hours a week of EFL instructions for a whole school year, children reached a level of language production comparable to a 2-year-old native speaker of the target language (Goorhuis-Brouwer & de Bot, 2010). In the same cohort, however, the rate of improvement in speaking proficiency, dramatically declined during the second year of L2 learning at school. At the end of grade 2, children did not show significant changes as compared to the year before, and a large variation in individual attainment was also recorded (Goorhuis-Brouwer & de Bot, 2010). Therefore, introducing L2 learning at very early stages of education might not be as effective as desired, if speaking proficiency is the only goal.

Parents who wish for their children to reach a highly functional proficiency in the L2 very early might opt for immersion education programmes, rather than relying on the L2

provision offered in mainstream schools. Immersion education is an umbrella term comprising a large variety of educational practices which aim to maintain (in the case of children who can already speak the second target language) or implement and develop L2 learning (Hickey & de Mejía, 2014). The purpose and structure of bilingual provision varies in different education systems around the world and is closely connected to socio-political factors (Bialystok, 2018; Jeffery & van Beuningen, 2020). For example, in the United States, dual-language schools (i.e., schools where children receive instructions in two languages; Hickey & de Mejía, 2014) have been established mainly with the aim of promoting English language acquisition alongside the academic success of children from minority language families (Jeffery & van Beuningen, 2020). The situation is quite different in Europe, where the language policy of the European Union (EU) sustains linguistic diversity and communication between its member states (European Union, 2008). Therefore, the institution of bilingual schools was favoured by the EU mainly with the view of adding a second European language for young speakers of the official language in each member state (Jeffery & van Beuningen, 2020). In the last two decades, a number of state-funded primary bilingual schools have opened in England following the initiative of groups of parents and teachers (Kasprzak, 2012). These schools teach part of their curriculum in English and the other part in another language, thus integrating the learning of subjects' content with the acquisition of the L2.

This thesis explores the effects of second language learning on young children's cognition. It has a twofold aim. On one hand, it addresses the question whether early second language learning in formal settings impacts on children's socio-cognitive development. On the other, it aims to contribute to the understanding of the influence of second language learning in natural contexts on one of the main areas affected by bilingualism, that is perspective-taking. Exploring the impact of a second language on different areas of young monolinguals' cognition

at the very beginning of their L2 learning (i.e. when L2 proficiency is minimal) will contribute to a better understanding of whether and to what extent distinct bilingual advantages depend on actual production in the second language.

In this introductory chapter, I will give an overview of the evidence for the impact of bilingualism on children's development, with particular focus on the areas where the bilingual advantage has been recorded, i.e., Executive Functions, creative thinking and social cognition. Furthermore, I will outline how the current thesis addresses open questions in these areas.

1.2 Literature review

The idea that speaking more than one language can be of advantage to children's cognition is relatively recent. For most of the twentieth century bilingualism was thought to have a detrimental effect on children's personal and social development (see Spitzer & Hakuta, 1986). The notion that two languages in a child's mind would thwart cognition was challenged only in the early 1960s by a study conducted by Peal & Lambert (1962) on French-English bilingual children in Canada. Peal and Lambert (1962) noted that previous research on the field did not take into account important confounding factors such as socio-economic status and often presented tasks of verbal intelligence which, when they were translated, the translation was not standardized, or otherwise were presented in the language where bilingual children had weaker knowledge. Contrary to what the Canadian researchers (1962) expected, bilingual children in their study outperformed monolinguals in both verbal and non-verbal measures of intelligence. Oddly, it took almost 30 years, after Peal and Lambert (1962) showed evidence of bilingual advantages, for academic interest to intensify on the topic. After an initial flourishing in the early 1990's of research showing that individuals who speak more than one language have enhanced cognitive skills, some more recent failures to replicate earlier results have questioned this notion.

In the last decade, there has been a lively academic debate about non-linguistic benefits of bilingualism. Although some studies have challenged the bilingual advantage because they did not find differences between bilinguals and monolinguals in cognitive tasks (e.g. Paap et al., 2017; Paap & Greenberg, 2013), there is still evidence for an advantage (see recent review in Grundy, 2020). It is therefore rather a question of finding the right research questions or the right approaches than dismissing the advantage completely. One type of the approach that is needed are longitudinal studies that clearly show how an advantage arises from learning a second language (Poarch & Krott, 2019). Another area is to better understand the mechanisms behind suggested bilingual advantages. Both of these are addressed in this thesis.

In the following, I will first describe three different areas in which bilingual children have been found to show perform superior compared to monolinguals and that are addressed in this study: executive functions, creative thinking and social development.

1.2.1 The bilingual experience and Executive Functions

Executive Functions (EFs) is a broad term for those higher-order processes needed in goal-directed actions. Three main processes have been identified, namely inhibitory control, switching and working memory (Friedman & Miyake, 2017). This set of skills are crucial for everyday life. For children they are particularly important for school activities. When young children are required to sit still for a while and listen to the teacher's instructions, they have to exert inhibitory control to resist, for example, the impulse to walk away and play with a toy they have noticed in the classroom. Switching is needed to face new situations where the usual response is no more effective. Lastly, working memory is required to remember teachers' instructions and carry out the task assigned. In preschoolers, EFs are predictive of school readiness and of future achievements in math (Espy et al., 2004; Nayfeld et al., 2013; Shaul &

Schwartz, 2014), literacy (Nayfeld et al., 2013; Shaul & Schwartz, 2014) and science (Nayfeld et al., 2013).

Many studies have reported a bilingual superiority in EFs (but see Paap et al., 2015, 2017; Paap & Greenberg, 2013), which has traditionally been explained referring to Green's (1998) Inhibitory Control Model of bilingual language processing and, more recently, to Green and Abutalebi's (2013) Adaptive Control Hypothesis. The main underpinning of these models is that the two languages of a bilingual speaker are jointly activated and always competing during their language production. Therefore, in order to perform a linguistic task in one language, bilinguals have to exert inhibitory control on the other language. As the mechanism of language selection/suppression relies on the domain-general cognitive control, the practice of supervising the two linguistic systems during language processing enhances bilinguals' EFs. This results in advantages in non-linguistic tasks that require the same types of executive control processes involved in bilingual language production.

Bilinguals' superiority has often been shown in tasks that demand to solve a conflict between cues or responses and therefore involve interference inhibition. In young bilinguals this advantage has been shown, for example, in their precocious ability to solve Piagetian-like conservation tasks (Piaget, 1971), where the visual appearance of a quantity is a deceptive information to override. Bialystok and Codd (1997) administered two tasks both assessing the concept of numbers to monolingual and bilingual four- and five-year-olds. Bilinguals displayed an advantage over monolinguals, but only in the task requiring to disregard a perceptually salient trait. Asked to share an even number of blocks in two equal piles, bilinguals were no better than their monolingual counterparts in indicating how many blocks there were in one pile after having counted the blocks in the other. However, the same bilingual children, presented with two towers made of different sized blocks, could more accurately indicate which one consisted of a greater

number of blocks without being misled by the different heights of the towers. Bilingual superiority seems to lie in the capacity of directing attention to the relevant feature of the problem while ignoring the confounding trait (Bialystok & Codd, 1997).

Other tasks where bilinguals have shown better performance than monolinguals are those that require a shift between rules or points of view. Advantage in these tasks has been related to bilinguals' practice of switching from one linguistic system to the other when they need to adjust their language to different linguistic contexts (but see Timmermeister et al., 2020). Four- and five-year-old bilinguals, for example, have shown superiority over same-aged monolinguals in a task where they were asked to sort the same cards according to different rules (the dimensional change card sort task; DCCS, Zelazo et al., 1996; this task will be described in detail in Chapter 2). Bilingual children aged 3 to 6 have also shown enhanced flexibility in reversing the interpretation of ambiguous figures, i.e. pictures that can be interpreted in two different ways such as the duck-rabbit or the man-mouse images (Bialystok & Shapero, 2005; Wimmer & Marx, 2014). This enhanced ability of switching from the initial interpretation of an image to the alternative one was found to be related to bilinguals' superior ability to shift between rules (Bialystok & Shapero, 2005).

The constant monitoring of two languages seems also to boost bilinguals' ability to hold and manipulate information in mind, i.e. working memory. This latter ability, however, seems to be more pronounced for bilingual children in tasks that heavily tax EFs (Blom et al., 2014; Morales et al., 2013). For instance, five- and six-year-old bilinguals performed comparably to their monolingual peers in the Forward Digit Recall task (a task that requires to repeat sequences of numbers in the same order of presentation) but they outperformed monolinguals in the Backward Digit Recall task (where the sequences need to be repeated in reversed order; Blom et al., 2014). Similarly, bilingual children aged five and seven showed superior performance in two

visuospatial tasks where they had to remember the positions of three frogs appearing on a 3X3 grid (Morales et al., 2013). In the easier version of the task, the three frogs appeared simultaneously on the grid, while in the more difficult variant the frogs appeared in sequence and children were also asked to remember the order of appearance. The bilingual advantage was higher in the latter version, which had extra EFs load.

Traditionally, the bilingual advantage in EFs has been associated with the speaking proficiency in the second language (Carlson & Meltzoff, 2008; Poarch & van Hell, 2012). However, studies on bilingual preverbal infants and toddlers have shown that exposure to multiple languages can enhance EFs regardless of the speaking competences (Mehler & Kovács, 2009; Poulin-Dubois et al., 2011; Singh et al., 2015). This raises the possibility that second language activities in early years of school might be beneficial to children's EFs, despite the very limited learning outcomes on the linguistic front. If so, educators and policymakers could consider the introduction of second language classes at the very initial stage of formal education in view of the benefits that it may have on cognitive control and on the other areas reviewed below. The existing literature on second language learning in formal settings mainly focused on children in upper grades of school and exclusively considered second language immersion programs. Very little is known about second language learning in early years of school and, importantly, no study has explored the effect of second language classes in mainstream education. The present study will, therefore, investigate early second language learning in both bilingual education and mainstream schools (Chapters 2 and 3).

1.2.2 The bilingual experience and creative thinking

Another area of cognition affected by bilingualism is creative thinking (see literature review in Ricciardelli, 1992b; van Dijk et al., 2019). Creativity has received different definitions,

but it is generally agreed that the main trait of a creative person lies in the ability of producing original and functional ideas, that means ideas that are novel but also effective and appropriate to the purpose for which they were generated (Simonton, 2008). Psychometric measures of creative potential have been developed based on Guildford's (1967) definition of divergent production, i.e. the "generation of information from given information, where the emphasis is upon *variety* and *quantity* of output from the *same source*" (Guildford, 1967 p. 213). Classic measures of creative thinking ask participants to produce a large number of different responses, either verbal or pictorial, starting from a given stimulus. Generally, responses are scored under four criteria corresponding to four different traits of divergent thinking: quantity of responses produced (which refers to trait of fluency), variety of conceptual classes that responses belong to (which refers to the trait of flexibility), uniqueness of ideas (which refers to the trait of originality) and amount of details given for each response (which refers to the trait of elaboration). A bilingual advantage in creativity tasks is well documented in all four traits (Kharkhurin, 2017) although results are mixed in regard to which of these aspects are particularly boosted (e.g. studies comparing highly proficient bilinguals to low proficient bilinguals have recorded different results).

The mechanism underlying bilingual superior creative thinking skills has not been clearly understood. Two main accounts have been proposed (van Dijk et al., 2019). One explanation links this advantage to bilinguals' superior EFs, the other grounds it on bilinguals' improved network of symbolic associations.

EFs play an important role in creative production (Beaty et al., 2014; Benedek et al., 2012; Zabelina et al., 2019). Constant updating and shifting, for example, is required to produce multiple alternatives in the search for the most effective solution to a problem or to dismiss more common ideas in order to come up with an original one. Inhibitory control is needed to

concentrate and persist on the task avoiding distractions (Kharkhurin, 2011). Research in the field has shown that fluency and flexibility scores in divergent thinking tasks are related to updating working memory (Zabellina et al., 2019) and inhibitory control (Benedek et al., 2012). Studies on bilingual young adults and preadolescents have also shown relationships with EF components and different aspects of creativity (Kharkhurin, 2011; Sampedro & Peña, 2019), but the link between bilingual creative potential and their superior EFs has not always been confirmed (Leikin et al., 2020). Kharkhurin (2011) found that high-proficient bilingual young adults' ability to produce innovative ideas (i.e. ideas that are both novel and functional) was positively associated with interference inhibition. In the same study, the researcher also found that less proficient bilinguals' generative capacity (i.e. the ability of producing and elaborating a large quantity of conceptually unrelated ideas) was linked to their ability of directing their attention to relevant information. In a study on bilingual preadolescents, Sampedro and Peña (2019) found a positive association between performance in a creativity task and scores in a task of general cognitive flexibility.

The alternative explanation for bilingual superior performance in creativity measures rests on the notion that semantic associations in the bilingual memory are structured in a broader and more elaborate network as compared to that of monolinguals (Kharkhurin, 2017). A mechanism of Language Mediated Concept Activation (LMCA) in the bilingual memory would favour associations between concepts which are unrelated for monolingual (Kharkhurin, 2008, 2017). According to the LMCA theory, when bilinguals retrieve one word in one of their languages, the corresponding word in the other is also activated because the two words share features at the conceptual level. The activation of the translation equivalent triggers further symbolic associations, as the conceptual representations of the two words do not perfectly overlap. Furthermore, associative connections between distant concepts are also activated when

two words share lexical features but have different meanings in the two languages. For example, the word “burro” means “donkey” in Spanish and “butter” in Italian. When a Spanish-Italian bilingual hears the word “burro”, both conceptual representations of “donkey” and of “butter” are initiated, thus establishing association between concepts that are very unlikely to be related in Spanish monolinguals or Italian monolinguals. It is argued that these ‘unusual’ activations lead to creative solutions. Kharkhurin (2017) tested the LMCA theory with a test of translingual priming, i.e. a lexical decision task where Russian-English bilingual and Russian monolingual were presented with pairs of words and pairs of non-words. Word pairs contained words that were semantically related in English but not in Russian (e.g. “ice” and “cream”) and semantically unrelated words in both languages. As semantically related words are processed faster (Meyer & Schvaneveldt, 1971). Russian-English bilinguals should have shown smaller response latencies for the pairs of semantically related words in English. This hypothesis was confirmed only for those bilinguals who were also highly proficient in English. Importantly, the effect of translingual priming was a predictor of bilinguals’ flexibility score in a measure of creative potential.

Studies on bilingual children have not directly tested either accounts, but both have been conjectured. The present study will address the EF account.

Furthermore, research on creative thinking and second language learning in formal settings is very scarce. The very few studies which considered children in Primary schools contain some ambiguities concerning earlier grades of schools. The main shortfall of the existing literature is the use of cross-sectional designs, which fails to make causal claims between second language education and creative thinking. Therefore, a longitudinal study is needed to determine whether early language learning at school can improve this area of cognition and whether an eventual improvement is related to enhancement in EFs. In addition, not much is known about

the level of second language education that is needed to bring about advantages in creative thinking. These issues are addressed in this thesis in a longitudinal study that tests the effect of different levels of language education on creative thinking skills in the first year of primary school (Chapter 3).

1.2.3 The bilingual experience and perspective-taking

The third main area impacted by bilingualism is social cognition. The ability of attributing mental states to oneself and others, otherwise known as Theory of Mind (ToM) or Mindreading, develops earlier in bilingual than monolingual children (see Schroeder, 2018 for a meta-analysis; but see Dahlgren et al., 2017; Kyuchukov & De Villiers, 2009). Three- and four-year-old bilinguals have been shown to outscore their monolingual peers in classic tasks of ToM, where they were asked to predict the action or the belief of a naive person who did not share their same knowledge of a situation (Goetz, 2003; Kovács, 2009). Bilingual early sensitivity to the perspective of other people is maintained during adulthood (Jávor & Javor, 2016; Rubio-Fernández & Glucksberg, 2012). In an eye-tracking study Rubio-Fernández and Glucksberg (2012) administered a classic ToM task, the Sally-Ann task, to bilingual and monolingual young adults. Participants were shown a short cartoon story where one character, Ann, stores her doll in a basket and goes away. While Ann is away the other character, Sally, removes the doll from the basket and puts it into a box. Participants were asked where Ann would look for her doll when she came back. Before answering the question, over half of participants directed their first look to the box (i.e., where they knew the doll had been moved to), which suggests that they tended to consider their own perspective first. Bilinguals, however, were less affected by egocentric bias as their first gaze was more often directed towards the basket (i.e., where the character left her doll) as compared to monolinguals.

Earlier explanations for bilingual children's superiority in ToM tasks have linked it to

bilingual enhanced EFs and, in particular, to superior inhibitory control (Goetz, 2003; Kovàcs, 2009). However, more recent studies have failed to find this link (Dahlgren et al., 2017; Diaz & Farrar, 2018) and other accounts have been proposed.

It has been suggested that growing up in a multilingual environment favours the development of enhanced social skills (Fan et al., 2015; Goetz, 2003; Liberman et al., 2017). Early experience that other people communicate in a language that differs from one's own would promote the understanding that different people have different knowledge (Goetz, 2003). Moreover, in order to communicate effectively, bilinguals have a constant need to monitor the languages spoken by their interlocutors. This would promote an early sensitivity to socio-pragmatic traits of the communicative context which monolingual children do not tend to consider (Goetz, 2003; Yow & Markman, 2011b, 2011a, 2015). Indeed, there is evidence that bilinguals pay attention to the paralinguistic features of the communicative act (Yow & Markman, 2011a, 2011b; 2015) and can better infer and understand others' emotion (Han & Lee, 2013). In a study by Yow & Markman (2011a) comparing four-year-old monolinguals to same aged bilinguals, monolinguals were as good as bilinguals at identifying a speaker's emotion when their tone of voice was in accordance with the lexical content (e.g. a sad situation reported in a sad voice), but bilinguals were better able to judge the speaker's emotion when paralinguistic cues and content were conflicting (e.g. a happy situation reported in a sad tone of voice). In another study, Han and Lee (2013) showed that 4- to 5-year-old bilinguals could more accurately judge a person's emotional state from their facial expression when the same was contrasting with the context (e.g. a boy with a happy face chased by a tiger). However, advantages in the tasks described above might partly be due to a superior ability to resolve the conflict between tone of voice and content of the communication (as in the case of Yow and Markman's, 2011, study) or between visual expression and situational context (as in the case of

Han & Lee's, 2013, study).

In sum, early bilingual experience has been shown to improve children's perspective taking abilities and enhance their pragmatic skills. However, no one, as far as we know, has explored the impact of early second language learning at school on children's communication abilities. Furthermore, recent studies have questioned the link between bilinguals' sensitivity to their interlocutors' perspective and their EF skills. A socio-pragmatic account has been proposed but not yet explored. For these reasons, we will first determine whether early second language learning in formal settings has an impact on perspective-taking and how this effect might be mediated by EF and moderated by the amount of second language exposure (Chapter 2). Furthermore, we will investigate both the EF and socio-pragmatic accounts of the bilingual perspective-taking advantage comparing monolingual and bilingual children on a communicative perspective taking task as well as on EF and a test of emotion understanding (Chapter 4).

1.3 Summary

As reviewed in the previous sections, early second language learning in natural settings has proved to enhance aspects of cognition, such as EFs, creative thinking and perspective taking, which are crucial to children's future academic and social life. It is not known whether these benefits can be brought about by early second language learning in formal settings (i.e. in schools). Findings from a longitudinal study would advise educators and policymakers on the opportunity of introducing second language classes from the early years of school.

On the theoretical front, the nature of the bilingual advantage in perspective taking is controversial. Recently, it has been speculated that this advantage is social in nature and is not linked to enhanced EFs as previously suggested. A study investigating the underpinning of

bilingual enhanced perspective taking skills would contribute to the understanding of the bilingual advantage in this area.

CHAPTER 2
DOES EARLY SECOND LANGUAGE LEARNING AT SCHOOL ENHANCE EXECUTIVE CONTROL AND SOCIAL COMMUNICATION ABILITIES?

2.1 Introduction

It is a common thought that learning a foreign language at a young age requires little or no effort from the learner and it is crucial for reaching a native-like proficiency in the target language. For these reasons, bilingual immersion programs at Primary school level have recently started to flourish and foreign language classes have also been introduced in mainstream education from early years of school. It is also with the aim of enhancing children's developmental processes that the European Union supports the introduction of foreign language activities at very early stages of a child's educational path (European Commission, 2011). However, there is no clear evidence that starting to learn a foreign language very early in life is either effortless or essential for the future linguistic mastery. The existence of a critical period after which second language learning abilities decline, has been challenged by many studies (for a review see Muñoz & Singleton, 2011) and higher attainments in foreign languages have been achieved despite starting to learn the target language in later stages of education. Moreover, the benefits of early second language learning on children's social and personal development remain largely wishful conjectures, as little research has been conducted on the cognitive advantages of early language learning (for a review of research on early foreign language learning, see Nikolov & Djigunović, 2006; for a review on pre-school dual language learners see Barac et al., 2014).

Nonetheless, the idea that a second language can improve children's socio-cognitive development is not just a mere speculation. The presence of multiple languages in the mind has been shown to be beneficial to different aspects of cognition and bilingual advantages in attentional control, problem-solving, symbolic representation and abstract reasoning have

regularly been reported (see meta-analysis by Adesope et al., 2010). Research has mainly focused on bilinguals who have acquired a second language under natural conditions by being exposed to different linguistic environments, having, for example, parents who speak different languages or being immersed in a language at home and another outside it. Recently, the effects of learning a second language in formal settings, such as a school or a language course, have started to attract interest. Studies showed that foreign language learning in formal environments can influence Executive Functions (Bak et al., 2016; Sullivan et al., 2014) and can also impact on the ability to find multiple original solutions to a problem, also referred to as divergent thinking (Ghonsooly & Showqi, 2012; Landry, 1973a, 1973b). Studies on adult bilinguals have mainly focused on advantages in EFs. However, enhanced cognitive outcomes in bilingual children have also been reported in other areas, such as visual perspective taking (Greenberg et al., 2013), Theory of Mind (review in Barac et al., 2014), communicative abilities (Fan et al., 2015; Liberman et al., 2017; Verhagen et al., 2017; Yow & Markman, 2011) and divergent thinking (Adi-japha et al., 2010; Leikin, 2013; Leikin et al., 2014; Ricciardelli, 1992a).

In this chapter I will first review the evidence for advantages in EFs and in social communicative skills of early second language acquisition in natural settings. I will then present a longitudinal study on the impact of early second language learning on these abilities in early years of school.

2.2 Literature Review

2.2.1 Advantage in Executive Function in bilingual children

EFs, or Cognitive/Executive Control, is a broad term which comprises different higher order processes that come into play when we need to face a novel situation (Diamond, 2006). EFs can be split into various subcomponents. But three main components have received general

recognition: Inhibition (or inhibitory control), Cognitive Flexibility (also called "switching" or "shifting") and Working Memory (WM; Diamond, 2013). Inhibitory control refers to abilities such as suppressing an automatic response, controlling one's emotion, delaying a gratification, staying focused and blocking out perceptual distractions. Cognitive Flexibility, instead, encompasses skills such as switching between tasks, applying new rules and shifting between points of view, by representing different visual perspectives or by considering different ways of thinking. Finally, WM is the ability of holding and manipulating information in mind (Diamond, 2006). Although evidence of bilingual advantage has been shown in all the three core EFs', enhancements in the latter one (WM), have not been reported as consistently as for the other two (Inhibition and Cognitive Flexibility; Barac et al., 2014).

As for inhibitory control, the effect of a second language does not seem to extend to all its aspects. Bilingual preschoolers were not better than their monolinguals peers at refraining from the impulse of opening a gift when promised a greater reward for their wait (delay of gratification) or at standing still and withholding motor actions for longer than they expected (delay inhibition; Carlson & Meltzoff, 2008). On the contrary, young bilinguals have shown superiority in tasks that require inhibition of attention (Barac et al., 2014; Bialystok & Martin, 2004; Carlson & Meltzoff, 2008). A typical task where bilinguals have displayed a superior ability to focus attention on a target and disregard misleading visual stimuli is the Attentional Network Task (ANT; Fan et al., 2002). In the child-friendly version of the task (Rueda et al., 2004), participants are required to press a left or a right button according to the orientation of a fish appearing in the middle of a screen. Neutral trials contain only one fish, while congruent and incongruent trials show a row of five fish. In congruent trials, all fish face the same directions and there is no visual conflict between the target (the central fish) and the flankers. In incongruent trials, however, a visual conflict is presented, as the flanking fish face the opposite

direction from the central one. Bilingual children are better at resolving the perceptual conflict in incongruent trials by responding faster (Yang et al., 2011) and more accurately (Mezzacappa, 2004; Yang et al., 2011; Yoshida et al., 2011) than same aged monolinguals.

Bilingual children have also shown superiority in tasks which require the ability to think flexibly and shift between rules. For example, six-year-old bilinguals were faster than same aged monolinguals in the Trail-making task (TMT) where they had to connect a series of numbers and letters with an uninterrupted line by following alternately the numerical and the alphabetical sequence (e.g. 1-A-2-B-3 etc.; Bialystok, 2010). The capacity to easily switch from one rule to another develops very early in bilingual children. This has been shown through the dimensional change card sort task (DCCS; Zelazo, 2006; Zelazo et al., 1996). In this task children are asked to sort a set of bivalent cards, for example red rabbits and blue boats, first by one dimension (e.g. by colour) and then by the other (e.g. by shape). Three-year-old children can usually sort the cards by the first rule presented, however, when they are asked to switch to the new rule, they fail to sort the cards correctly as they persevere in applying the previous rule. Children's ability to switch attention from one dimension of the card to the other increases dramatically between the age of three and five, when they also become better able to adjust their behavior according to the novel rule. As a result of this spurt in executive control, by the age of five children can easily pass the task (Zelazo, 2006). The development of the ability of shifting between rules seems to be accelerated for bilingual children (Bialystok, 2007), who display more successful performance in various versions of the DCCS task earlier than monolinguals (Bialystok, 1999; Bialystok & Martin, 2004; Bialystok & Shapero, 2005; Carlson & Meltzoff, 2008; Okanda et al., 2010).

In order to understand the nature of the bilingual advantage in the DCCS, it is important to know what it is that young children struggle with in this task. Zelazo et al. (1996) ruled out a

number of scenarios. They showed that three-year-olds do not fail to apply a new rule in the post-switch phase because they cannot resist a pre-learned behavior (as they fail in the post-switch phase even if the pre-switch is limited to only one trial). It is also not because they cannot represent the second rule (as they are able to verbalise the rule when requested) or because they cannot hold the rule in mind (as they fail to apply the rule even if they are reminded of it at every trial). Instead, Zelazo and colleagues (1996) suggested that children's inability to regulate their behaviour according to the new rule is due to their lack of reflection on the two rules. Children who fail the post-switch phase are not able to represent a higher-order rule that would enable them, firstly, to recognise both rules as applicable to the same context and, subsequently, to select the one appropriate to the new demand.

Bialystok and Martin (2004) noted that if Zelazo and colleagues' (1996) suggestion was correct, the bilingual superiority in the DCCS task would indicate that bilinguals reach improved representational skills earlier than monolinguals. However, this appears not to be the case (Bialystok & Martin, 2004). Comparing 4- to 5-year-old monolinguals to same-aged bilinguals in different versions of the DCCS tasks, Bialystok and Martin (2004) found that bilingual children outperformed monolinguals only when a perceptual conflict in the stimuli had to be resolved. If the rules were not inherent to conflicting perceptual qualities of the stimuli and required to focus on semantic traits instead (e.g. water animals or land vehicles, sorted first according to the "kind rule", i.e. animal vs vehicle, and then according to the "place rule", i.e. water vs land) monolinguals were as good as bilinguals in applying the post-switch rule. Therefore, Bialystok and Martin (2004) concluded that the difference between bilingual and monolinguals would not lie in the ability to hierarchically represent more complex rules, as both monolinguals and bilinguals were able to manage the representations of pre- and post-switch rules when cards bivalence was not perceptual. Instead, the bilingual advantage would stem from

an enhanced ability in conceptual inhibition, i.e. in the ability to inhibit the representation of the stimuli activated during the pre-switch phase by a prepotent perceptual trait. In other words, as Diamond (2006) put it, the difficulty that children face in the DCCS task would consist in representing the same stimulus first in its "colourness" and, then, in its "shapeness". In the case of a red rabbit, for example, children would have to represent it in its "redness" in the pre-switch phase and then in its "rabbitness" in the post-switch. According to Bialystok and Martin (2004), bilingual children would be more flexible in shifting from one representation of the rabbit to the other because of their superior inhibitory control, which is not just confined to the inhibition of a motor response in favor of a more appropriate one (as in the ANT) but also comprises the inhibition of conceptual representations in favor of an alternative one.

The underpinning of the DCCS task is, however, controversial (see a monograph on the DCCS in Zelazo et al., 2003). Despite a general recognition that processes of inhibition/selection of the relevant dimension are involved, it has been suggested that superior representational abilities are, nonetheless, needed to shift between rules. These abilities would be requested precisely when stimuli present perceptual conflicts (Zelazo et al., 2003).

Evidence of a bilingual advantage in EFs has been generally explained as a domain-general enhancement derived by the constant control of different linguistic systems during language processing and, particularly, during L2 production (Pivneva et al., 2012). If so, then gaining EF advantages at early stages of foreign language learning would be very unlikely, especially in pre-school settings where learners' L2 proficiency is extremely limited and production in the target language is neither forced nor expected by teachers. However, actual production in more than one language does not seem to be crucial to bilinguals' EFs superiority. Being raised in bilingual households has elicited advantages in executive control also in preverbal infants (Mehler & Kovacs, 2009; Singh et al., 2015) and 24-month-old toddlers

(Poulin-Dubois et al., 2011). For instance, Mehler and Kovács (2009) found that seven-month-olds raised in monolingual environments showed less cognitive flexibility than same-aged infants who were daily addressed in different languages by their parents. Both "monolingual" and "bilingual" infants were equally able to habituate and look for a puppet to appear on one side of a screen after hearing an auditory prompt. However, when the puppet started to pop up on the opposite side, "monolinguals" continued to anticipate its appearance on the previously learnt location, while "bilinguals" were better at changing their predictive response and looked towards the novel position. In this case, bilingual superior switching and inhibition abilities cannot be accounted for by their training in suppressing the non-relevant linguistic system during production. Therefore, Bialystok (2015) suggested that immersion in multiple languages with different sounds, structures, intonations and speakers, might solicit infants to constantly appreciate contrasting features. This would spur infants' attentional processes more than a monolingual environment, where such diversity in stimulations is not present.

2.2.2 Advantage in communicative abilities in bilingual children

Bilingual children have not only been found to have enhanced EFs, but they also show superiority in communicative abilities. Similarly to EFs, advantages are not conditional on being able to actively speak a second language. Fan et al. (2015) showed that advantages in social communication can be obtained by simple exposure to a multilingual environment, regardless of the actual use of a second linguistic system. They (2015) tested 4- to 6-year-olds in a communication game, otherwise known as the Director Task (DT; Keysar et al., 2000). Children were presented with an array of boxes and were asked to move objects around the grid following the instructions of a "Director" who had a limited view of the array. In order to interpret the

instructions correctly, participants had to consider the Director's point of view and avoid moving objects that their interlocutor could not see. Three groups of children took part, namely "bilinguals" (i.e. children who were able to speak more than one language), "exposure children" (i.e. children regularly exposed to more than one language but able to speak just one) and "monolinguals" (i.e. children with either no or very little experience of any other language beyond that of their native one). Both the bilingual and exposure group performed similarly in the task and showed a better ability to take the perspective of the Director than monolingual children. This advantage in the Director task is very remarkable, as even adults are prone to egocentric errors in this task despite the conceptual easiness in terms of the visual perspective-taking skills involved (Apperly et al., 2010). Fan and colleagues (2015) concluded that experience of multiple languages equips children with socio-cognitive tools which, unrelated to their actual proficiency in second language, enables them to communicate more effectively with others.

It has been suggested that such bilingual advantages in pragmatic skills might derive from earlier experience of communication breakdowns (Wermelinger et al., 2017). Growing up in a bilingual environment gives children opportunities to interact with speakers of different languages, for which their passive or active proficiency might be limited and is usually inferior to monolinguals. This exposes them to communication failures from a very early age, but, in turn, also gives children more opportunities to refine their communicative abilities by enhancing their attention to the paralinguistic features of communication. Compared to their monolingual peers, bilingual toddlers have been shown to be better at repairing a misunderstanding in a communicative situation (Wermelinger et al., 2017) and bilingual preschoolers have shown a superior ability to consider multiple socio-pragmatic cues simultaneously when trying to understand a speaker's intention (Verhagen et al., 2017).

Bilinguals' enhanced communicative skills have been shown to develop from a very early age, that is when speaking proficiency in both languages are still very limited. In a simplified version of the Director Task, 14- to 17-months-olds raised in multilingual homes showed better ability to understand instructions from the perspective of their interlocutor as compared to same-aged infants who had been exposed to one language only (Liberman et al., 2017). This superiority was found even in infants who had minimal exposure to another language. Therefore, researchers concluded that the underlying factor for bilinguals' enhanced performance might not be superior EF such as inhibitory control but some heightened, still undefined, social skill instead. Nevertheless, as Liberman and colleagues (2017) acknowledged, the possibility that EFs play an important role in bilinguals' superior perspective-taking ability in referential communication cannot be totally dismissed. Evidence from studies on perspective-taking in online referential communication shows that the ability to interpret instructions from the point of view of the interlocutor is related to higher inhibitory control ability (Nilsen & Graham, 2009).

2.2.3 Summary and motivation for present study

As discussed above, research on children who acquired their second language under natural conditions have found a bilingual superiority over monolinguals in EFs and social online communication. While earlier findings of bilingual enhanced inhibitory control and switching abilities have commonly been interpreted as the result of the constant inhibition of one language while using the other, research on preverbal infants raised in bilingual homes indicated that the actual production in the two languages is not essential to the EF enhancement. Similarly, although bilingual superior sensitivity to other points of view has been linked to enhanced EFs (Goetz, 2003; Greenberg et al., 2013; Kovács, 2009), their superior pragmatics abilities were not

found to be related to the actual use of a second linguistic system (S. P. Fan et al., 2015). Instead, these seem to arise due to the challenges that children immersed in multilingual environments are faced with (Yow & Markman, 2015; Wermelinger et al., 2017). Interestingly, as pointed out by Bialystok (2015), exposure to linguistic variety could also underpin bilingual enhancement in EFs at its early stage: while monolingual surroundings would offer less contrasting features to attend, multilingual ones would, namely linguistic dissimilarities. This could boost EFs.

If exposure to different, contrasting, linguistic environments promotes progression in EFs and social communication abilities, then one would expect that teaching monolingual children a foreign language should result in advancement in these areas of cognition. The current study therefore investigates whether monolingual children who had not grown up in a bilingual environment, would benefit from experiencing a second language in a formal setting. We recruited children from monolingual households at their entrance into formal education and tested their inhibitory control, switching and perspective-taking abilities before and after being exposed to another linguistic system. We hypothesized that an encounter with a foreign language at school might enhance children's EFs (inhibitory control and switching) skills and their perspective-taking abilities in online communications. Furthermore, in consideration that the amount of exposure to a second language might be important to trigger attentional processes and perspective-taking, we differentiated early language learners by the amount of exposure to the second language that they received and compared them against non-language learners. We therefore compared children entering into bilingual education (i.e., being presented with a substantial immersion into a second language), children in mainstream schools with weekly foreign language classes (ranging from 45 to 60 minutes per session) and children in mainstream schools that did not have any foreign language provision. We expected that exposure to a second

language would result in faster development in both EFs and communicative perspective-taking abilities. But we also anticipated that a very limited exposure as in the weekly language learners might not be enough to boost children's development in these two areas of cognition.

2.3 Method

2.3.1 Participants

One hundred and nine 4- to 5-year-old monolinguals (mean age = 57.7 months, range = 50-65 months) took part in the experiment. Ten children were not included in the analysis because they were exposed to a second language at home (n = 6), showed reluctance to perform the tasks and completed only one (n = 2) or did not take part in the second testing point because they had moved school (n = 2). Therefore, the final sample consisted of 99 children, 47 females.

Participants attended Reception class in Primary schools in England and were assigned to one of three groups according to the type of formal education in the second language that they received. Thirty-two children (M = 56 months, range = 50-62 months; 11 female) attended bilingual schools (BilS), twenty-nine children (M = 57.2 months, range = 51-64 months; 15 female) had weekly second language classes at school (WL2) and thirty-eight children (M = 59.5 months, range = 53-65 months; 21 female) did not have any second language education (NoL2). The bilingual schools were located in Abingdon (Oxfordshire) and Bromley (South East London). In both bilingual schools, children were exposed to the L2 for approximately half of the school time. However, the two schools differed in terms of L2 timetable and of subjects taught through the mean of the L2. The school in Abingdon had three forms, a French-English, a German-English and a Spanish-English form; while the school in Bromley was a French-English bilingual two-form entry. In Abingdon all subjects were taught through the L2 for half of the week and through English for the other half. During L2 immersion time, the second language

was used also during breaks by teacher assistants, but at any time children could resort to English to communicate. In Bromley, children were exposed to both English and French every day. English was used in the morning to teach core subjects, while French was used in the afternoon for the other subjects. The WL2 schools were located in Claines Worcester (Worcestershire), Crewe (Cheshire East), Morden (South West London) and Sutton Coldfield (West Midlands). French was taught in two schools (in Claines Worcester and in Morden), while German (in Cheshire East) and Spanish (in Sutton Coldfield) was taught in the other two. In all schools the L2 was taught once a week by a specialist teacher. The length of the L2 classes ranged from 30 to 60 minutes. The NoL2 schools were located in Bognor Regis (West Sussex) and Redditch (Worcestershire).

Information on family language background, parents' education, parents' employment and annual family income was collected through a questionnaire completed by parents (see Table 2.1.1 in Appendix). All children's parents were born and brought up in UK or in an English-speaking country, English was the only language spoken at home and children had no daily exposure to any other language rather than English at home. SES index was obtained combining information on maternal and paternal education, occupational status and annual income. Mothers' and father's levels of education were measured on a 1-6 scale, where 1 was "no formal educational qualification" and 6 "Masters/Doctoral degree, NVQ 5, or equivalent". The two values were, then, converted into 0-1 scale values and averaged to obtain a single parental education index for each participant. Annual family income was measured on a 1-7 scale, where 1 was "less than £15,000 and 7 was "£65,000 or more", and subsequently converted into a 0-1 scale value. As for parental occupational status index, mothers' and fathers' occupations were classified according to the Standard Occupational Classification Hierarchy redacted by the Office for National Statistic. The values obtained were, then, converted into 0-1

scale values and averaged. The three indexes (parental education, annual income, and occupational status) were finally averaged to generate the SES index.

A series of one-way ANOVAs were conducted on age, Socio-economic status (SES) index, receptive vocabulary and non-verbal reasoning skills scores. Groups did not differ in SES, $F(2,95)=1.0$, $p=0.389$, but there was a significant difference of age, $F(2,96) = 7.2$, $p=.001$, $\eta_p^2=.131$. A Bonferroni post hoc test revealed that BilSs were significantly younger than NoL2s ($p =.001$). The difference between BilSs and WL2s was not significant ($p=.670$) but the difference between WL2s and NoL2s showed a trend towards significance ($p = .063$), with WL2s younger than NoL2s. Receptive vocabulary and non-verbal reasoning abilities were measured through the British Picture Vocabulary Scale 3 (BPVS; Dunn et al., 1997) and the Coloured Progressive Matrices (Raven's; Raven et al, 1998) respectively. In order to test initial scores' reliability, participants were tested twice, at initial testing point (TP1) and then, after 24 weeks, at final testing point (TP2). There was a very good test-retest reliability for BPVS scores (Cronbach's alpha = .812), and also an adequate test-retest reliability (Cronbach's alpha = .634) was found for Raven's. Therefore, TP1 scores were used as baseline measures and analysed with the means of one-way ANOVAs in order to check whether the three groups differed in receptive vocabulary and non-verbal reasoning skills. The analysis revealed that there was no difference between groups either in receptive vocabulary, $F(2,96)=.4$, $p=.657$, or in non-verbal reasoning abilities, $F(2,96)=.2$, $p=.790$.

2.3.2 Design and Procedures

Children were administered a first battery of tests at the beginning of the school year, when all children still had minimal or no exposure to a second language, then, after 24 weeks, the testing was repeated. Both initial and final testing batteries consisted of three testing sessions which took place in different days. Two sessions lasted approximately 30 minutes and one about 15 minutes. In the first 30-min testing session participants were presented with the Raven's Coloured Progressive Matrices, followed by the creativity task (results for this task will be presented and discussed in the following chapter) and the Dimensional Change Card Sort Test. In the second 30-min testing session the Attention Network Test and the British Picture Vocabulary Scale-III were administered. The 15-min testing session presented the Director Task alone.

2.3.3 *Measures*

Background Information Questionnaire

A modified version of Luk and Bialystok's (2013) Language and Social Background Questionnaire was sent to parents, who filled it in at home and returned it with the consent form in a sealed confidential envelope to the school office. Information on participant's gender, date of birth, handedness, extra-school activities (type and amount of hours per week), computer and video games usage (amount of hours per week), number of older and younger siblings, maternal and paternal ethnicity and country of upbringing, maternal and paternal level of education, maternal and paternal employment status and occupation, annual family income, participant's place of birth and previous residence in non-English speaking countries, languages spoken by participant and daily exposure to other languages besides English at home. Parents were also asked to describe their child's language status by choosing from four options: monolingual,

exposed to different languages, bilingual or multilingual. Only children who were described as monolingual and had no exposure to other languages besides English at home were accepted in the study.

Coloured Progressive Matrices (Raven et al., 1998)

This is a measure of non-verbal reasoning. Children were presented with 36 incomplete figural patterns (A, B and AB sets) and were asked to select the missing part of each pattern from a choice of six options. For each correct answer one point was rewarded, with a maximum score of 36. Stimuli were presented on a Dell Latitude 5580 laptop via E-prime (E-Studio 2.0)

The British Pictures Vocabulary Scale III (BPVS; Dunn et al., 2009)

This is a measure of receptive vocabulary. Children were shown tables presenting 4 pictures. For each table the experimenter pronounced a word, and the child was required to point to the picture that matched with the word. Tables were grouped in 14 sets of 12 items. Children went through the tables till they made 8 or more wrong selections within a set. The score was calculated subtracting the total number of errors from the number of tables presented.

Attention Network Test for children (ANT; Rueda et al., 2004)

The ANT (J. Fan et al., 2002) measures the three attentional networks of alerting (the ability to reach and maintain the state of attentiveness), orienting (the ability to regulate attention according to a sensory input), and executive control (the ability to supervise responses and resolve conflicting stimuli). Traditionally, a bilingual advantage has been reported only in the executive control network. However, at the very initial stages of L2 learning, young learners with minimal or no L2 comprehension skills, have to rely on the paralinguistic features of the

communicative situation in order to understand classroom instructions. This might force L2 learners to maintain sustained attention to the environment and look for non-linguistic cues. We therefore hypothesized that L2 instructed classes might also boost the other two attentional networks of orienting and alerting, in addition to the conflict network.

The task is a flanker task (Eriksen & Eriksen, 1974) modified with warning cues likewise in a cue reaction time task (Posner, 1980). We administered the children-friendly version (Rueda et al., 2004) which features fish instead of crosses. Participants had to "feed" a hungry fish by pressing a left or right button according to the orientation of the fish. Neutral trials presented a single yellow fish facing left or right, while congruent and incongruent trials presented the target fish in the middle of a row of five identical fish. The flanking fish either faced the same direction as the central one (congruent trials) or looked towards the opposite side (incongruent trials). All trials started with a fixation cross in the middle of the screen and stimuli appeared above or below fixation. The three flanker type conditions (neutral, congruent and incongruent) were combined with four cue conditions, no cue, double cue, central cue and spatial cue, for a total of 12 conditions. In no cue conditions the target stimuli were not preceded by any warning cues, while in double cue conditions two asterisks, one above and one below fixation, were shown simultaneously before the target. In central cue conditions a single asterisk preceded the target stimuli by appearing in the position of the fixation cross, while in spatial cue conditions the asterisk anticipated the actual position of the coming stimuli, showing up either above or below the fixation cross. The alerting index was obtained comparing children's performance in no cue trials (where no warning was given) to their performance in double cue trials (where children's attention was alerted by two asterisks); the orienting index by comparing children's performance in central cue condition (where the warning cue did not provide any information about the position of the stimuli) to their performance in spatial cue condition

(where the cue was predictive of the stimuli position); the executive control, or conflict, index by comparing children's performance in congruent trials (where no conflicting stimuli had to be resolved) to their performance in incongruent trials (where target fish and flankers were in competition). After the initial fixation period of 400 ms, the warning cue appeared for 150 ms followed by the target after 450 ms. The target was displayed till the child responded, with a maximum duration period of 1700 ms. Correct responses received a visual and auditory feedback as the target fish moved its mouth making bubbles and a "Wohoo" sound was played. Incorrect or late responses were followed by an auditory feedback only, represented by a wrong buzzer sound. Stimuli were presented on a Dell Latitude 5580 laptop via E-prime (E-Studio 2.0). Responses were recorded using a button box with a right button showing a picture of the target fish oriented to the right and a left button showing the target fish oriented to the left.

The experimenter introduced the task placing a laminated card representing a right-facing target fish on the button box, above the buttons. Children were told that the fish was very hungry, and their task was to feed him by pressing one of the two buttons. Pointing first to the card and to the right button, the experimenter said: "Sometimes the fish is facing this way. In this case you need to press this button". Then, presenting a card with a target fish facing left and, pointing to the left button, the experimenter continued "but sometimes the fish is facing this other way. So, which button do you need to press if he is facing this other way?". The correct answer was suggested if the child showed hesitation. Afterwards, the experimenter presented a card with a row of five fish all facing left and, pointing to the central one, said: "Sometimes the fish is not alone on the screen, he is with other fish, but you need to look at him in the middle. Which button do you press to feed him?" and, showing the right-oriented row of fish, "which button do you press if he is facing the other way?". Finally, the experimenter presented a card showing one of the two incongruent flankers and, pointing to the target fish, said: "I told you

that you always have to look at the fish in the middle and not at the others because sometimes the other fish are tricky. They want to trick you and they go in the opposite direction. But you need to feed the fish in the middle and not the others, so which button do you press for the fish in the middle?" and, showing the other flanker stimuli card, continued "and which button do you press for this other one?". Correct responses were demonstrated, and further explanation were given in case of incorrect answers. Children were told that there would be a small cross in the middle of the screen and that they had to keep their eyes on the cross as the target fish would appear above or underneath it. The presence of different cue types trials was not mentioned. Children were encouraged to keep their right pointer finger on the right button and their left pointer finger on the left button before starting the task and told to press the relevant button as quickly as possible when the fish appeared on the screen.

There were 24 practice trials followed by two blocks of 48 trials presenting the 12 conditions, twice with the target fish facing left and twice with the target fish facing right, in random order. Accuracy and Reaction Times (RTs) were recorded. Omissions of response were recorded as errors.

Dimensional Change Card Sort (DCCS; Zelazo, 2006)

Both the standard and the advanced version of the DCCS (Zelazo, 2006) were administered and the scored were summed. In the standard version a set of 14 play cards (70x110mm) were used. Seven cards showed a red rabbit and the other seven a blue boat. Children were presented with two 168x116x45 mm transparent containers with no lids. A target card was stuck on the inside back of each container and it was clearly visible to the child. Target cards showed respectively a blue rabbit and a red boat so that children were never asked to simply match cards identical to the target. The experimenter told children that they were going

to play some games with the cards. The experimenter said: “The first game is called the *colour game*. In the colour game you need to sort the cards by colour, so all the red cards go here [pointing to the container featuring the red target card] and all the blue cards go here [pointing to the container featuring the blue target card]”. Then, the experimenter showed a red rabbit card and said: “Here’s a red card. Where does it go?” Children were asked first to point to the correct container and then to place the card face down into it. The same was repeated with a blue boat card. Correct responses were demonstrated if the child made mistakes. After the two practice trials, there were six pre-switch trials presenting three red rabbit cards and three blue boat cards in pseudo-random order, no feedback was given. When the child completed the 6 pre-switch trials, the experimenter said: “Now we are changing game, we are playing another game called *picture game*. In the picture game you need to sort cards by picture, so all the rabbits go here [pointing to the container with the target rabbit card] and all the boats go here [pointing to the container with the boat target card]. Here’s a rabbit, where does it go?”. The card was handed to the child who put it face down in one of the containers, no feedback was given. There were 6 post-switch trials presenting 3 red rabbit cards and 3 blue boat cards in pseudo-random order. Both in pre- and post-switch trials the card was presented mentioning the relevant feature (“Here’s a red/blue card” for pre-switch, “Here’s a rabbit/boat card” for post-switch) and handed to the child who put the card face down into one of the containers. One point was given for each card sorted correctly, with a maximum score of 12 points.

Immediately after the child completed the post-switch, the advanced version of the DCCS was presented. In the advanced version, a new set of 14 cards were used: 8 red rabbit cards and 6 blue boat cards. Half of the rabbit cards and half of the boat cards were also labelled with a rainbow at the bottom of the card, the other half were marked with the black outlines of both a rabbit and a boat next to each other. The experimenter showed the new set of cards to the

child and said: “Now we are going to play another game with this special set of cards. In this set, some cards have a rainbow and some cards have two small pictures. If the card has got a rainbow [showing a rainbow-labelled rabbit card], it’s a colour-game card and you have to play the colour game, but if the card has got two small pictures [showing an outlines-labelled rabbit card], it’s a picture-game card and you need to play the picture game”. Then, the experimenter handed the rainbow card to the child and said: “This has got a rainbow, so it’s a colour game card. Can you remember the rule for the colour game?” If the child failed to remember the rule, the experimenter said: “In the colour game, red cards go here and blue cards go here [pointing to the corresponding target cards]. This is a colour game card, where does it go?” If the child placed the card in the wrong container, the mistake was corrected, and the rule reminded again. The same procedure was repeated with a picture-game rabbit card. The two practice trials were followed by 12 trials presenting 3 picture-game rabbit cards, 3 colour-game rabbit cards, 3 picture-game boat cards and 3 colour-game boat cards in a pseudo-random order. In all trials the card was presented hinting at the relevant rule (“Here’s a colour-game/picture-game card”). For each card sorted correctly 1 point was rewarded, with a maximum score of 12 points. The maximum total score for both standard and advanced version was 24 points. Scores were calculated on children first responses, repairs (i.e. when children corrected their first responses and moved a card from one box to the other) were not taken into account. At the second testing point, play cards featured a yellow flower instead of a red rabbit and a blue car instead of a blue boat. Accordingly, the two target cards showed a blue flower and a yellow car. At the second testing point, the same presentation procedure as at the initial testing was followed.

The Director Task (DT; Keysar et al., 2000)

The ability of taking the interlocutor’s point of view during a conversation was assessed

through a communication game, otherwise known as Director Task (DT; Keysar et al., 2000). Children followed the instructions given by a *director* and moved objects around a 4x4 array of boxes. An assistant played the part of *director*, while the experimenter took note of the child's behaviour. Assistant and child were seated in front of the grid on opposite sides, facing each other, and the experimenter was seated beside the child. On the *director*'s side 4 boxes were blocked by slats, thus creating a limited view of the objects on the grid. 8 objects were placed on the grid, 3 of which in the slatted boxes. Children were first shown the grid from the *director*'s side, with the assistant sitting across from them. The experimenter said: "We are playing a game with this grid. I put some objects on the grid, but from this side we cannot see all the objects that are on the grid. She/He [the assistant] can see everything that is on the grid, but we cannot see everything because some objects are hidden behind these slats [pointing to the blocked boxes]". First, you tell her/him [the assistant] to move something on the grid, then, if she/he moves the right object, we will swap places and she/he will tell you what to move". Then, the experimenter suggested the first instruction to the child: "Can you see two cups? One big and one small? Tell her/him to put the big cup under the brown dog". After the child had repeated the instruction, the assistant moved a bigger cup which was in a blocked box, deliberately committing a mistake. At this point, the experimenter, with a tone of confused surprised, would ask the child: "Oh! Did she move the right cup?" If the child did not acknowledge the mistake, then the experimenter said "Yes, that's a big cup but we could not see that big cup from our side!" and explained the error. Afterwards the experimenter said to assistant: "Let's try again! Remember that from this side we cannot see everything that you can see". A second critical instruction was presented, and this time assistant selected the target object. The child was, then, shown the grid from the assistant's privileged point of view and made aware that the correct object had been selected despite the presence of a referential alternative (the same object in a slightly different size) in

one of the blocked boxes.

After the two practice trials, there were 12 trials in 4 different displays. For each display, three instructions were given, one of which was critical due to the presence in the privileged ground of a distractor object. To reduce learning effects, after each set of instructions the grid was rotated 90° anti-clockwise so that the covered slots changed their position in the grid. 1 point was rewarded for each correct selection in critical trials, for a maximum score of 4 points. Scores were calculated on children first responses, repairs (i.e. when participants initially selected one object but afterwards corrected themselves and moved another object) were not taken into account. At the second testing point all objects were replaced by new ones, however, the presentation order of critical instructions was kept the same as in the first testing point.

2.4 Results

Scores of each task were analysed with the means of a two-way ANOVA, with Testing Point (TP) as a within-subject factor (TP1 vs TP2) and Group as a between-subject factor (BilS, WL2, NoL2). Whenever there was an interaction, TP1 and TP2 scores were analysed separately with a between-participant one-way ANOVA. In addition, for each control variable (i.e. age, SES index, passive vocabulary and non-verbal reasoning scores), we checked whether it correlated with the dependent variable of interest (see table 2.1.2 , 2.1.3 and 2.1.4 in appendix). If any of them did, then we followed up the initial ANOVA with an ANCOVA that included the correlating control variables as covariates. We entered centered scores as covariates instead of the raw scores so as to estimate the main effect of the within-participant factor Condition as in the 2x2 ANOVA (see Delaney & Maxwell, 1981).

2.4.1 Attentional Networks Task

Preliminary Analysis

We noticed that some children had a very high error rate in the ANT task. Therefore, we calculated how many correct trials were needed for a participant to score statistically above chance. As all congruent, incongruent and neutral trials required a response between two alternatives, performance was assessed against a 50% chance baseline. 57/96 has a one-tailed probability of 0.041 by binomial test, so we included in the analyses only children who reached at least 60% accuracy at TP1. Therefore, the final sample for this task consisted of 76 children (26 BilSs, 24 WL2s and 26 NoL2s). Before analysing Response Times (RT), we removed RTs faster than 200 ms (anticipatory responses) and slower than 2.5 Standard Deviation (SD) above the mean of each participant, which amounted to 19.5% of trials being excluded. RTs of incorrect responses were not considered in the analyses. Omissions of response were recorded as errors.

In order to be able to compare cue and flanker conditions consistently between the groups, overall mean accuracy and overall mean RTs for each group were compared. Table 2.2 in Appendix shows the mean of overall correct responses by group at TP1 and TP2. A two-way ANOVA revealed a main effect of TP, $F(1,73) = 114.6$, $p<.001$, $\eta p^2=.611$, but no effect of Group, $F(2,73) = 1.1$, $p=.339$, or interaction between TP and Group, $F(2,73) =1.6$, $p=.210$. This suggests that all the three groups similarly improved their performance at TP2 as an effect of developmental change (see Figure 2.1)

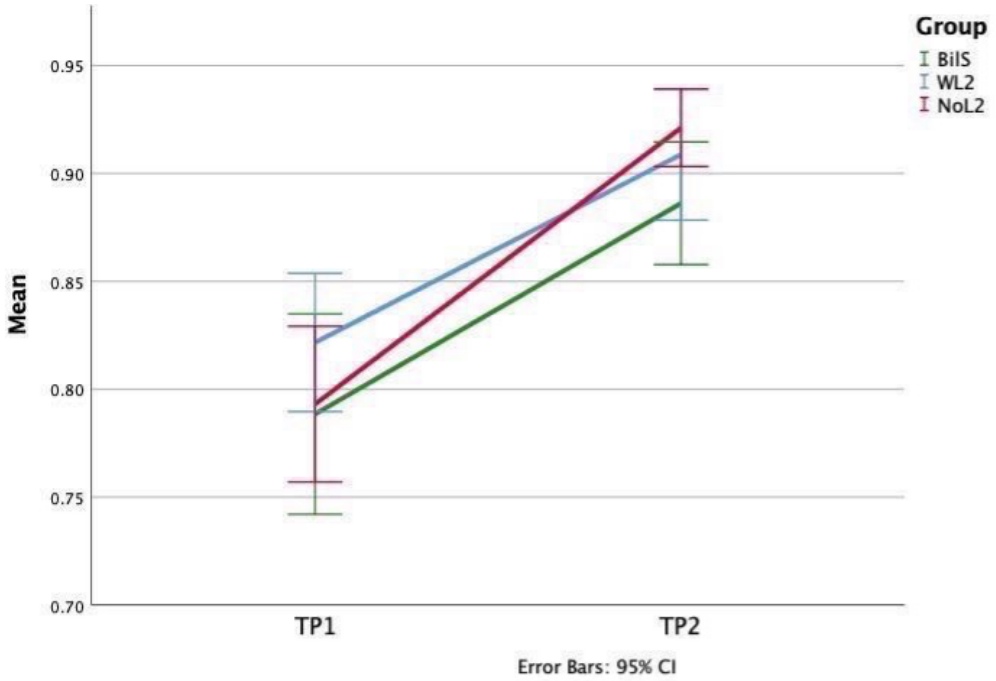


Figure 2.1. ANT - Mean of overall correct responses by Groups at TP1 and TP2

Table 2.2 in Appendix shows the mean of overall RTs by group at TP1 and TP2. A two-way ANOVA revealed a main effect of TP, $F(1,73) = 132.0$, $p<.001$, $\eta p^2=.644$, but no effect of Group, $F(2,73) = 1.3$, $p=.287$, or interaction between TP and Group, $F(2,73) = .5$, $p=.596$, suggesting that all groups improved at TP2 but no group was faster at either TP1 or TP2 (see Figure 2.2).

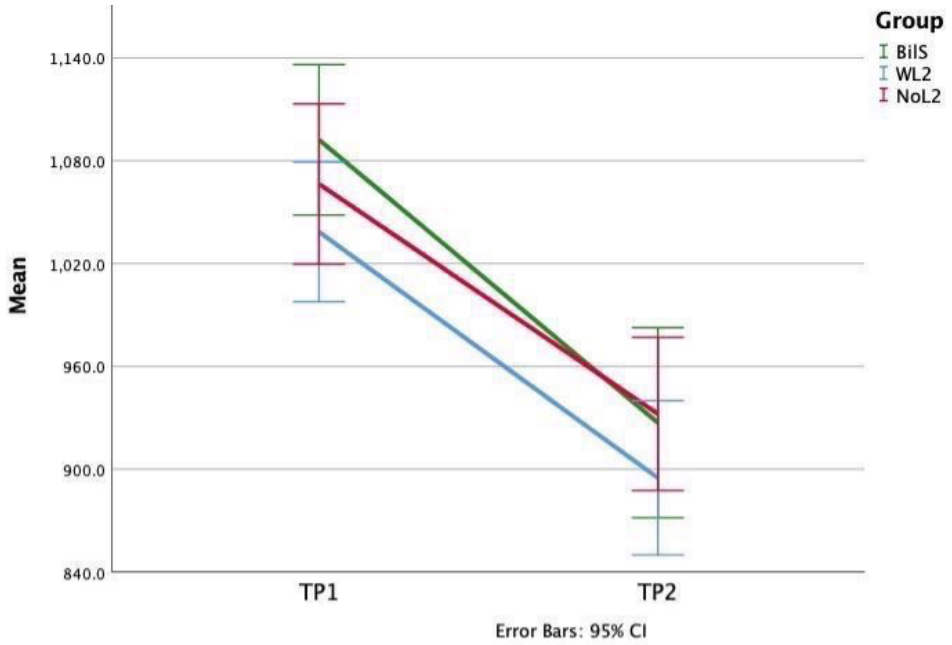


Figure 2.2 ANT - Mean of overall RTs (in ms) by Group at TP1 and TP2

After checking that all groups were similar in overall accuracy and speed at both TPs, the three indexes of Alerting, Orienting and Conflict were calculated. However, as we noticed that during the task children appeared to move their eyes away from the fixation cross very frequently, a preliminary t-test against 0 was conducted for each flanker and cue condition (at both TPs, on RTs and accuracy) to check whether the task worked properly. All tests revealed significant differences at the $p<.001$ level. Tables 2.4 and 2.5 in appendix show respectively means of correct responses and means of RTs by Group and cue type conditions, while tables 2.6 and 2.7 show respectively means of correct responses and means of RTs by Group and flanker type conditions.

Alerting. Alerting index was calculated by subtracting the mean of Double Cue condition from the mean of No Cue condition so that a low value corresponded to a higher alertness for accuracy and a high value corresponded with higher alertness for RTs. Table 2.8 in Appendix shows the mean of alerting accuracy at TP1 and TP2. For alerting accuracy, there was

no effect of Testing Point, F(1, 73)= 1.9, p=.174, or of Group, F(2, 73)= .7, p=.517, or interaction between Testing Point and Group, F(2, 73)= 1.5, p=.228 (see Figure 2.3). As SES index was negatively correlated with alerting accuracy at TP1 (r= -.279, n= 75, p= .015) and BPVS scores were positively correlated with alerting accuracy at TP2 (r= .226, n= 76, p= .050), the centered variables were entered as covariates into an ANCOVA. After accounting for SES and passive vocabulary, there still was no effect of Testing Point, F(1, 70)= 3.0, p=.192, or of Group, F(2, 70)= .7, p=.500, or interaction between Testing Point and Group, F(2, 70)= 1.7, p=.192. Showing that the three groups were equals in alerting accuracy and none of them progressed at TP2.

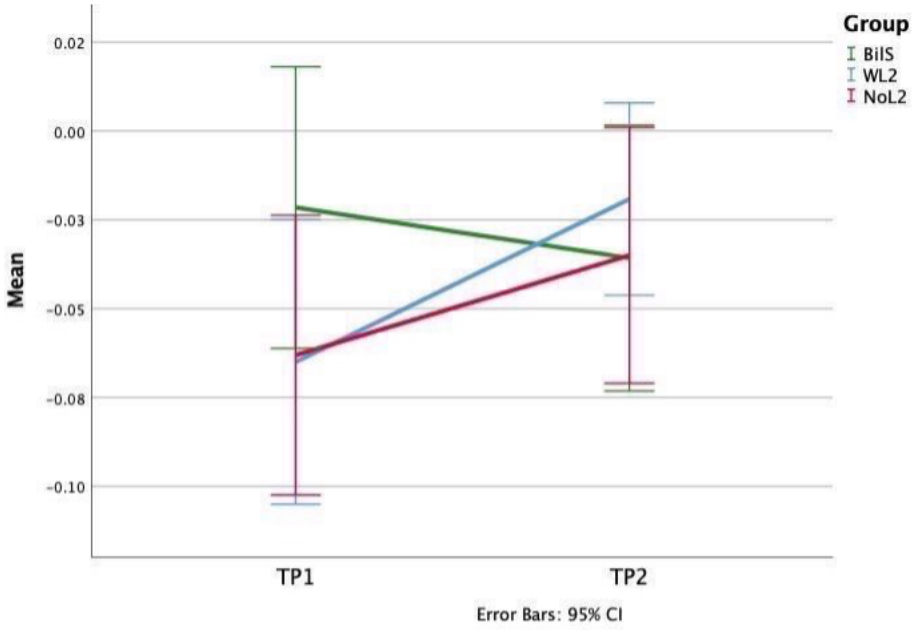


Figure 2.3. ANT - Alerting accuracy means by groups at TP1 and TP2

Table 2.9 in Appendix shows the mean of alerting RTs at TP1 and TP2. For alerting RTs, there was a main effect of Testing Point with an increase of alerting RT index at TP2, F(1, 73)= 12.1, p=.001, η_p^2= .142, and also a main effect of Group, F(2, 73)= 5.5, p=.006, η_p^2= .131, but no interaction between Testing Point and Group, F(2, 73)= .6, p=.547 (see Figure 2.4). A

Bonferroni post hoc test was carried out locate group differences. It showed that WL2s had significantly higher alerting RT index as compared to BilSs (p=.004), but there was no significant difference between WL2s and NoL2s (p=.331) or between BilSs and NoL2s (p=.226). However, as Raven's scores were positively correlated with alerting RT at TP2 (r= .227, n= 76, p= .048), the centered variable was entered as covariate into an ANCOVA. After accounting for non-verbal reasoning ability, there still was a main effect of Testing Point, F(1, 72)= 12.0, p=.001, η_p^2= .143, and the main effect of Group, F(2, 72)= 5.8, p=.005, η_p^2= .138. There was no interaction between Testing Point and Group, F(2, 72)= .6, p=.557. Follow up analyses confirmed the pattern found with the initial ANOVA. WL2s had significantly higher alerting RT index as compared to BilSs, F(1,47) = 12.6, p=.001, η_p^2= .212 but not as compared to NoL2, F(1,47) = 2.4, p=1.28, η_p^2= .049. The difference between BilSs and NoL2s was not

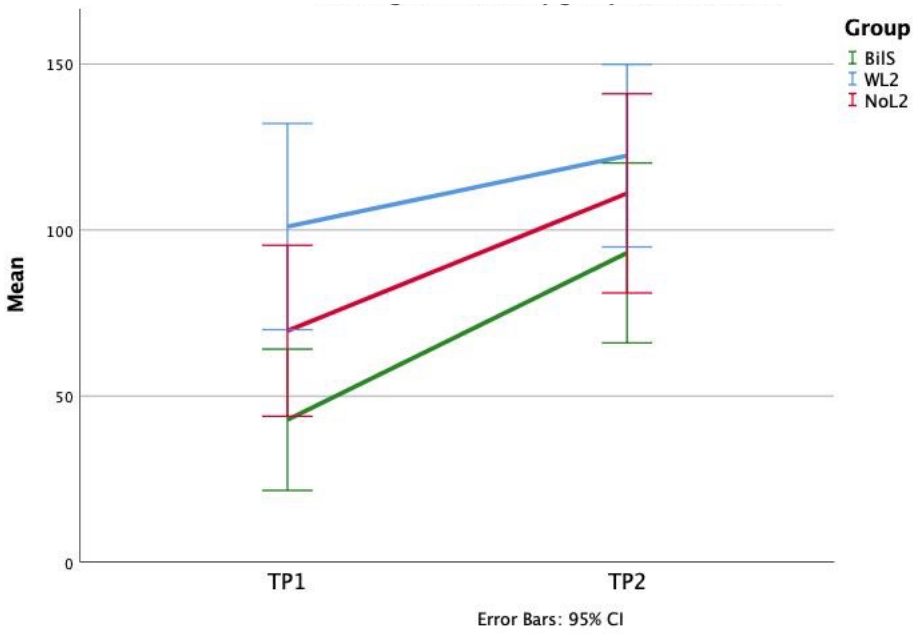


Figure 2.4. ANT - Alerting RTs means by Group at TP1 and TP2

significant, F(1,49) = 12.6, p=.074, η_p^2= .064.

Orienting. Orienting index was calculated subtracting the mean of Spatial Cue condition from the mean of Central Cue condition accuracy or RTs so that a low value corresponded to a better orienting for accuracy and a high value corresponded with better orienting for RTs. Table 2.10 in Appendix shows the mean orienting accuracy at TP1 and TP2. For Orienting accuracy, there was no overall effect of TP, F(1,73)= .0, p=.982, or of Group, F(2,73)= .4, p=.650, or interaction between TP and Group, F(2,73)= .9, p=.430 (see Figure 2.5). Showing that all groups were equals in terms of orienting abilities and there was no improvement at TP2. As Raven's scores were negatively correlated with orienting accuracy at TP1 (r= -.254, n= 76, p= .027), the centered variable was entered as covariate into an ANCOVA. After accounting for non-verbal

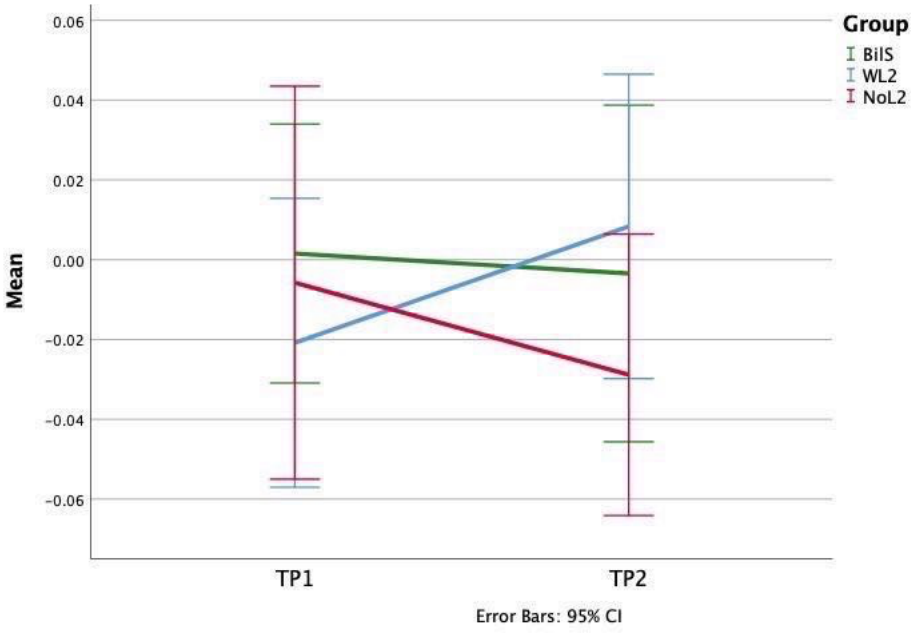


Figure 2.5. ANT - Orienting accuracy mean by Group at TP1 and TP2

reasoning ability, there still was no main effect of TP, F(1,72)= .0, p=.983, or of Group, F(2,72)= .5, p=.638, or interaction between TP and Group, F(2,72)= .9, p=.409.

Table 2.11 in Appendix shows the mean orienting RTs at TP1 and TP2. For Orienting RTs, there was no main effect of Testing Point, F(1,73)= 1.3, p= .258, or of Group, F(2,73)= 1.0, p= .373. However, the interaction between Testing Point and Group was significant, F(2,73)=

3.4, p= .038, η_p^2= .085. Follow up analysis revealed a marginally significant difference between groups at TP1, F(2,73)=3.2, p=.046, η_p^2=.081, but not at TP2, F(2,73)=.3, p=.742. To locate the difference at TP1 a Bonferroni post hoc test was carried out. It showed that initially WL2s had higher scores than NoL2s (p=.04), but WL2s' and BilSs' scores were not significantly different (p=.740), nor were BilSs' and NoL2's (p=.511). As shown on Figure 2.6, the trajectory of change between TP1 and TP2 was different for WL2s as compared to both BilSs and NoL2s. WL2s decreased in orienting RT index at TP2, while the other two groups, WL2 and BilS, increased. WL2s showed higher scores than the other two groups at TP1(and the difference between WL2s and NoL2s was also marginally significant), but they reported (not significantly) lower scores as compared to both BilSs and WL2s at TP2. This caused a cross-over interaction, even if no group showed an advantage at the final TP. A series of paired-samples t-tests was conducted to compare Orienting RTs at TP1 and at TP2 for each group. Analyses showed that neither BilS, t(25)=-.625, p=.583, or WL2, t(23)=1.111, p=.278, improved their performance at TP2. However, NoL2 performed better at TP2 as compared to TP1, t(25)=-2.319, p=.029.

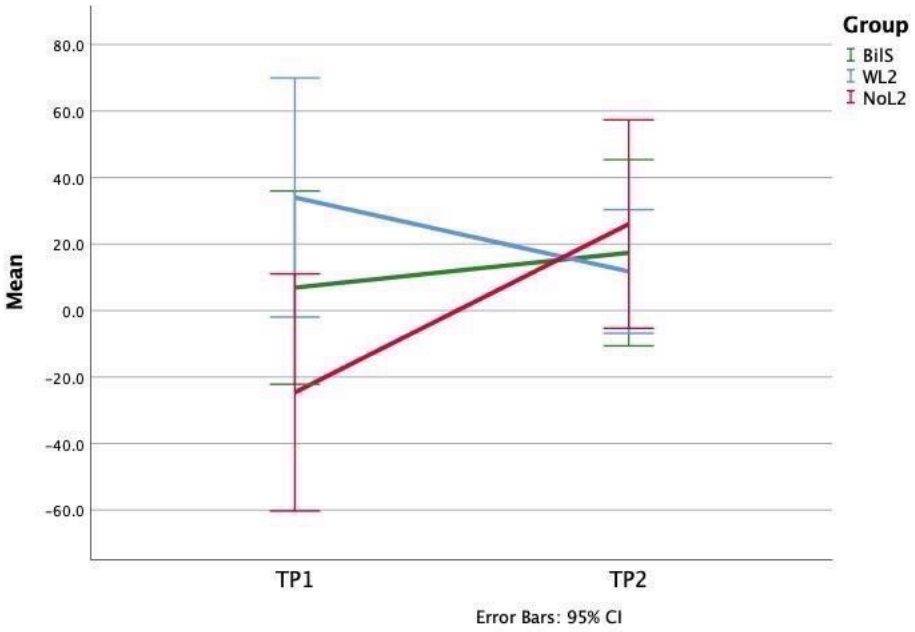


Figure 2.6. ANT - Orienting RTs mean by Group at TP1 and TP2

Conflict. Conflict index was calculated subtracting the mean of congruent trials from the mean of incongruent trials so that a high value corresponded with good conflict resolution for accuracy and a low value corresponded with good conflict resolution for RTs. Table 2.12 in Appendix shows the mean conflict accuracy at TP1 and TP2. For conflict accuracy, there was a main effect of TP (TP1<TP2), $F(1, 73)= 25.7$, $p<.001$, $\eta_p^2= .260$, but no effect of Group, $F(2,73)= .7$, $p=.482$, or interaction between TP and Group, $F(2,73)=1.3$, $p=.293$ (see Figure 2.7). However, as age was positively correlated with conflict accuracy at TP2 ($r= .265$, $n= 76$, $p= .021$), the centered variable was entered as covariate into an ANCOVA. After accounting for age, there was still a main effect of TP, $F(1, 72)= 25.4$, $p<.001$, $\eta_p^2= .260$, but not of Group, $F(2, 72)=.4$, $p=.703$, or interaction between TP and Group, $F(2, 72)=1.2$, $p=.324$.

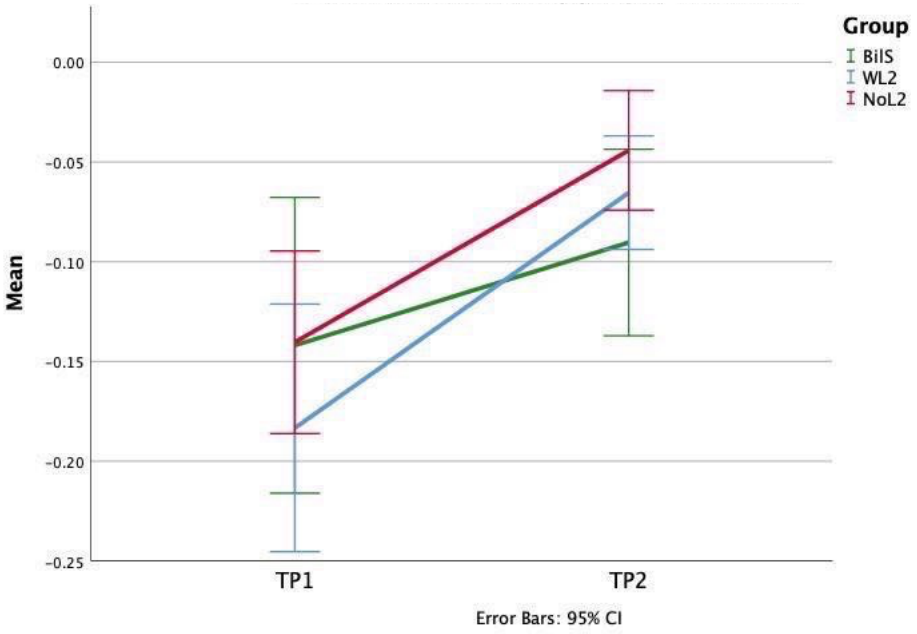


Figure 2.7. ANT - Conflict accuracy mean by Group at TP1 and TP2

Table 2.13 in Appendix shows the mean conflict RTs at TP1 and TP2. For conflict RTs, there was no effect of Testing Point, $F(1, 73)= 1.5$, $p=.224$, or of Group, $F(2, 73)= 2.0$, $p=.141$, or interaction between Testing Point and Group, $F(2,73)= .8$, $p=.470$ (see Figure 2.8). However, as age and SES index were negatively correlated with conflict RTs at TP1 (respectively, r= -

.251, n= 76, p= .029; r= -.232, n= 75, p= .045), the centered variables were entered as covariates into an ANCOVA. After accounting for age and SES, there still was no main effect of TP, F(1, 70)=.6, p=.461, or of Group, F(2, 70)= 1.1, p=.338, or interaction between TP and Group, F(2,70)= .6, p=.546.

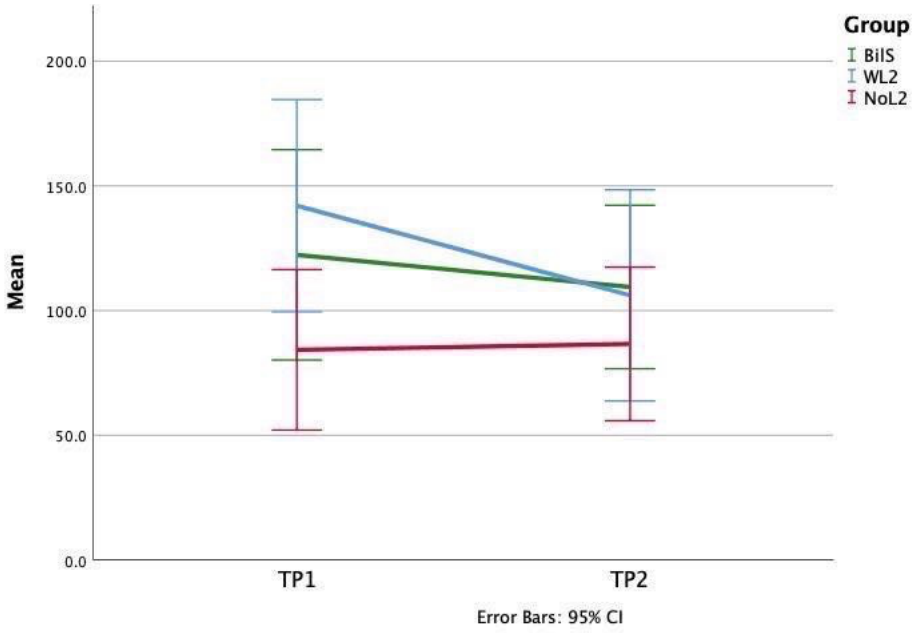


Figure 2.8. ANT - Conflict RTs mean by Group at TP1 and TP2

2.4.2 Dimensional Change Card Sort Task

Table 2.14 shows the means of DCCS at TP1 and TP2. There was a significant effect of TP, F(1, 96) = 124.7, p < .001, ηp^2 = .565, and of Group, F(2, 96) = 3.5, p = .033, ηp^2 = .069. The interaction between TP and Group was also significant, F(2, 96) = 11.1, p < .001, ηp^2 = .188 (See Figure 2.9).

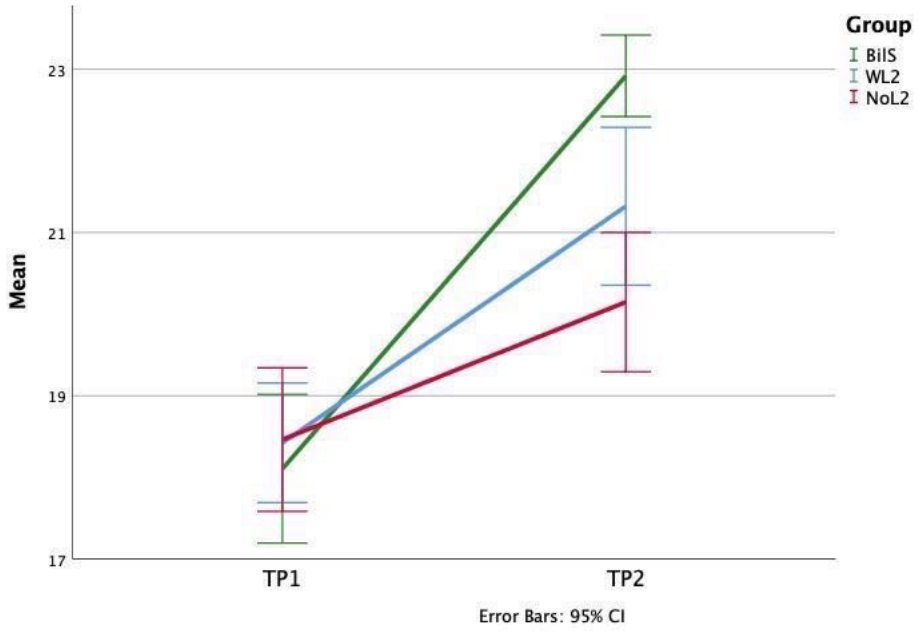


Figure 2.9. DCCS - Mean of correct responses by Group at TP1 and TP2

Follow-up analyses revealed no significant differences between the groups at TP1, F(2, 96) =.2, p =.807, but at TP2 the differences between the groups were significant, Welch F (2, 57.71) = 17.5, p<.001. A games-Howell post hoc test showed that BilS had an advantage both on WL2 (p=.012) and on NoL2 (p<.001), while WL2 and NoL2 did not significantly differ (p=.161). However, as BPVS positively correlated with DCCS at both TPs (r=.360, n= 99, p<.001, r=.332, n=99, p=.001, respectively) and Ravens correlated with DCCS at TP1 (r=.229, n=99, p=.023), the two centered variables were entered as covariates into an ANCOVA. After accounting for passive vocabulary and non-verbal reasoning skills, there was still a significant effect of TP, F(1, 94) = 122.5, p <.001, ηp^2 = .566, and of Group, F(2, 94) = 3.8, p = .025, ηp^2 = .075, and a significant interaction between TP and Group, F(2, 94) = 11.0, p < .001, ηp^2 = .190. Follow-up analyses confirmed that there were no significant differences between the groups at TP1, F(2, 94) =.6, p =.574, but at TP2 groups differed significantly, F(2, 94) = 13.7, p < .001, ηp^2 = .226. Follow-up comparisons revealed a significant BilSs' advantage both over WL2, F(1,

57) = 8.1, p = .006, ηp^2 = .124, and over NoL2, F(1, 66) = 31.6, p<.001, ηp^2 = .324, also WL2, however, showed a significant superiority over NoL2 with a medium effect size, F(1, 63) = 4.7, p = .035, ηp^2 = .069.

2.4.3 Director Task

Table 2.15 in Appendix shows results of the Director Task. There was a significant effect of TP, F(1, 96) = 67.2, p < .001, ηp^2 = .412, but no effect of Group, F(2, 96) = 2.1, p = .126. The interaction between TP and Group was also significant, F(2, 96) = 14.9, p < .001; ηp^2 = .237 (see figure 2.10). Separate analyses at the two points showed no significant difference of Group at TP1, F(2, 96) = 1.3, p = .293, but at TP2 the difference was significant, Welch F (2, 62.92) = 7.1, p=.002. A games-Howell post hoc test showed that both BilS and WL2 performed significantly better than NoL2 (p=.001 and p=.013, respectively), but there was no significant difference between BilS and WL2 (p=.741). However, as BPVS positively correlated with DT at both TPs (respectively r=.287, n= 99, p=.004 and r=.273, n=99, p = .006), the variable was entered as covariate into an ANCOVA. After accounting for passive vocabulary, there was still an effect of TP, F(1, 95) = 66.5, p <.001, ηp^2 = .412, but no effect of Group, F(2, 95) = 2.0, p = .141. The interaction between TP and Group was still significant, F(2, 95) = 14.7, p < .001; ηp^2 = .236. Follow ups analysis revealed that there was no difference between groups at TP1, F(2, 95) = 1.0, p = .387, but the groups differed significantly at TP2, F(2, 95) = 8.9, p < .001; ηp^2 = .158. Follow-up comparisons revealed that BilS and WL2 had significantly higher scores as compared to NoL2, F(1,67) = 12,9, p=.001, ηp^2 = .161 and F(1, 64) = 9.2, p=.004, ηp^2 = .125 respectively, while BilSs' and WL2s' scores did not significantly differ, (1, 58) = .2, p = .624.

Furthermore, as DCCS at TP1 positively correlated with DT at both TPs (respectively r=.258, n= 99, p=.010 and r=.228, n=99, p = .023), the centered variable was added as covariate into the previous ANCOVA. After accounting for passive vocabulary and switching ability, there was still an effect of TP, F(1, 95) = 66.6, p <.001, ηp^2 = .412, and the effect of Group showed a trend towards significance, F(2, 95) = 2.7, p = .072. The interaction between TP and Group was still significant, F(2, 95) = 14.7, p < .001; ηp^2 = .236. Follow up analysis revealed that there was no difference between groups at TP1, F(2, 95) = 1.0, p = .387, but the groups differed significantly at TP2, F(2, 95) = 8.9, p < .001; ηp^2 = .158. Follow-up comparisons revealed that BilS and WL2 had significantly higher scores as compared to NoL2, F(1,67) = 12,9, p=.001, ηp^2 = .161 and F(1, 64) = 9.2, p=.004, ηp^2 = .125 respectively, while BilSs' and WL2s' scores did not significantly differ, (1, 58) = .2, p = .624.

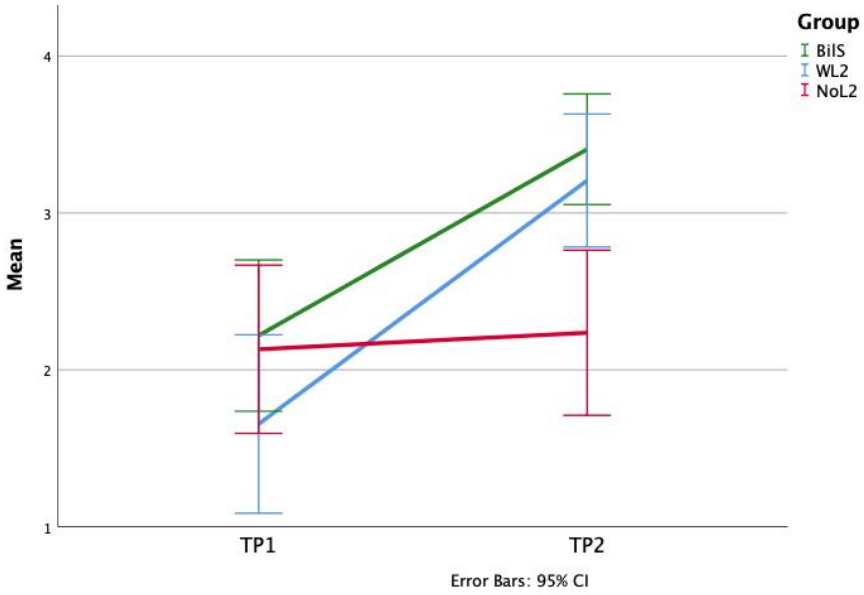


Figure 2.10. Director Task - Mean of correct responses by Group at TP1 and TP2

2.5 Discussion

The current study explored the effect of learning a second language at school on the cognitive development of children who had always been exposed to only English before. We tested their cognitive flexibility, attentional network and referential perspective-taking skills at the entrance of formal education and after 24 weeks, that is before and after being exposed to the new language. The most striking result to emerge from the study is that even a limited weekly exposure to a second language promotes children's social communication skills and cognitive flexibility. Our study also shows that enhancement in switching ability depends on the amount of L2 exposure. By contrast, exposure to a second language did not impact on children's attentional network.

At the initial testing point the three groups matched in all the baseline measures and performed comparably in the experimental tasks. However, after 24 weeks, the groups showed different developmental trajectories for cognitive flexibility and perspective taking. At the second testing point, bilingual school children outperformed both the other two groups in the switching task, and the advantage was confirmed after accounting for passive vocabulary and non-verbal reasoning skills. Surprisingly, when passive vocabulary and non-verbal reasoning were accounted for, also weekly L2 learners showed higher switching skills as compared to non-L2 learners with a medium effect size.

In regards to switching, our results differ from some earlier findings on children in bilingual education (Carlson & Meltzoff, 2008; Esposito & Baker-Ward, 2013; Kaushanskaya et al., 2014), but they are consistent with others (Nicolay & Poncelet, 2013, 2015) and in line with previous findings on "natural" bilinguals (Bialystok, 1999; Bialystok & Martin, 2004; Bialystok & Shapero, 2005; Carlson & Meltzoff, 2008; Okanda et al., 2010). Some methodological

differences between our study and those that failed to find a superiority for bilingual school children over mainstream school children in the DCCS task might explain the dissimilarity in the findings. The most important difference is that those studies (Carlson & Meltzoff, 2008; Kaushanskaya et al., 2014) were cross-sectional and, therefore, participants' switching abilities before starting school were not known. Initial cognitive flexibility might not have matched between the groups and, for this reason, the effect of bilingual education on children's switching abilities cannot be ruled out by the results of those studies. Another difference lies in the age of participants. Children in both Carlson and Meltzoff's (2008) and Kaushanskaya et al.'s (2014) studies were older (i.e., 5- to 7-year-olds) than those in our experiment (i.e., 4- and 5-year-olds). Given that success in the DCCS task is strongly age-related, there is the possibility that an earlier advantage of bilingual school children might not have been captured by those studies because of a subsequent developmental change in the control group. Furthermore, our experiment differed from Carlson and Meltzoff's (2008) on two other main aspects. Firstly, the control group in Carlson and Meltzoff's (2008) study was composed of children who had some weekly exposure to a second language "at school or at home" (Carlson & Meltzoff, 2008 p. 286). In light of our findings, i.e. that also a limited weekly exposure to a second language impact on DCCS performance, a control group composed of children exposed to a L2 might have prevented to record the effect of bilingual education on cognitive flexibility. Secondly, Carlson and Meltzoff (2008) administered a variant of the advanced DCCS which might have taxed EFs components differently from the version we used. Following Zelazo's (2006) version, we asked children to sort six "colour-game" cards and six "picture-game" cards presented in pseudo-random order. This required children to constantly shift between the two sorting rules. By contrast, in Carlson and Meltzoff's (2008) variant, children were presented with only four switch rule cards out of a total of twenty cards and, therefore, children had to shift between rules less frequently but also

exercise stronger inhibitory control (as one rule had predominance over the other). WM was also taxed differently in Carlson and Meltzoff's (2008) as compared to our version of the task. In Carson and Meltzoff (2008) the switch from the dominant rule (the shape rule) to the other rule (the colour rule) was signaled on the four switch cards by a symbol unrelated to the rule itself, that is a star. Children were reminded of the rule only once, after ten trials. In our version, colour game cards and shape game cards were both labelled with a symbol connected to the sorting rule (a rainbow for the colour game cards and the picture outlines for the picture game cards) and, most importantly, each card was presented to the child hinting at the relevant rule (i.e. "Here's a colour game card/a picture game card"). This was done in order to relieve WM load from the task and have a measure that reflected the ability to shift between rules as much as possible.

Contrary to what we found for switching, no group showed an accelerated improvement in any of the aspects of the ANT, indicating an equivalent development of the three attentional networks of alerting, orienting and conflict across the groups. While all groups were faster and responded more accurately in the ANT at TP2 than TP1, groups did not differ. Similar results were found for the three attentional networks. As for alerting, no group showed improvement in accuracy and all groups showed similar improvement rates in RTs (WL2 had an initial advantage over BilS that was maintained at TP2). As for orienting, there was no improvement in accuracy for any of the groups and only NoL2s showed a RT progress but, importantly, their RTs did not differ from the other two groups at any TP. The only network which recorded enhancement in accuracy at TP2 was conflict, but all groups recorded similar rates of progress. By contrast, no group improved in conflict RTs. Overall, these results suggest that second language learning did not influence children's attentional abilities.

Our results on inhibition are in accordance with previous studies which did not find any advantage in inhibitory control for children in bilingual education (Carlson & Meltzoff, 2008;

Esposito & Baker-Ward, 2013; Nicolay & Poncelet, 2013). Our findings are in line with the notion that the length of L2 exposure and the degree of proficiency in the second language are both crucial to enhance inhibition (Bialystok & Barac, 2012; Carlson & Meltzoff, 2008; Poarch & van Hell, 2012). It has been shown that the level of proficiency in the second language is positively related to attentional control in children who acquired their second language either in natural (Sorge et al., 2017) or formal settings (Chung-Fat-Yim et al., 2020). It is very likely that both L2 learning groups in our study at TP2 had little or very minimal proficiency in the second language. Weekly L2-learners, in particular, had had very little exposure and their acquisition of the L2 was presumably restricted to some basic vocabulary and to formulaic expressions used in classroom routines or in games and songs. As for children in bilingual schools, despite having had a more extensive and varied experience of communicative situations in the second language, which might have made them develop some further comprehension skills, their speaking proficiency and actual speaking production in L2 were, nonetheless, most likely limited as they could communicate with teachers and peers in English even during L2 instructed classes. Our failure to find an advantage for L2 learners in the three attentional networks, and in conflict in particular, at TP2 could be due to their insufficient length of exposure and to their minimal proficiency in the second language. However, as we did not measure children's L2 proficiency, this explanation remains speculatively. Regarding the ANT, 23 out of 99 participants had to be excluded, as their error rates were above 40% (i.e. the threshold level to score statistically above chance) at the first TP. At the first TP, children's motivation declined for the task once they made an error and struggled to stay focused on the task. As a result, frustration rather that inadequate conflict resolution might have been the cause for some of the children's poor performance at TP1. At TP2, 97 participants out of 99 performed above chance, with 87 of them reaching at least 75% accuracy. Given the age of children at TP1, other tasks might have been

more appropriate to capture potential differences in attentional skills improvement between the groups.

The different effect of L2 learning on the two EF components might be due to the fact that different aspects of EFs are recruited at a very initial stage of L2 acquisition, when L2 comprehension rather than L2 production is required. Children's representational network might be enriched, for example, by the acquisition of new labels for familiar referents and this might imply a more frequent shifting between representations during language comprehension. However, as children do not need to actively use the new L2 linguistic items, they might lack the practice of inhibiting their L1 competitors during language production. For this reason, inhibitory control might not have been enhanced as much as switching in our groups of L2 learners, who had close to none or very little practice in language production. There is evidence that enhancement inhibitory control and switching abilities are differently related to the bilingual experience. Bialystok and Barac (2012) administered a flanker task and a computerized switching task very similar to the advanced DCCS (children had to sort blue cows and red horses alternatively by color and by shape) to children in bilingual education who had different degrees of bilingualism. They found that, while flanker scores were predicted by L2 proficiency, switching abilities were not related either to L2 proficiency or to length of time spent in bilingual education. Furthermore, other studies have shown advantages for upper graders in bilingual schools in different measures of switching but not in inhibitory control tasks (Esposito & Baker-Ward, 2013; Nicolay & Poncelet, 2013, 2015).

The other very striking result of our study is that early language learning at school, even if it is limited to one weekly class, boosts children's perspective taking abilities. In line with Fan et al.'s (2015) study, our experiment recorded superior performance in the DT at TP2 for the two groups of children exposed to a second language over non-exposed pupils. Notably, the two

groups of L2-learners performed equally, regardless of the amount of L2 exposure they had. When cognitive flexibility was accounted for, L2 learners' perspective-taking advantage remained, suggesting that, although cognitive flexibility and perspective taking skills are related, improvement in DT are not ultimately due to improvement in switching skills. This supports the idea that early experience of linguistic diversity enhances children's socio-communicative skills, but this enhancement is not due to superior EFs (Fan et al., 2015).

An explanation for successful rule-switching in the DCCS relates it to children's ability to redescribe the same cards with novel criteria (Kloo & Perner, 2003, 2005; Perner & Lang, 2002). Failure to apply a novel sorting rule to a red rabbit card, for example, would lie in the child's inability of describing the card first as "a red thing" and then as "a rabbit". This difficulty would not be due to scarce inhibitory control, but, rather, to the child's inability to "think about one object in different ways" (Kloo & Perner, 2005 p. 53). Learning that a same object is named differently in another language might favor children's ability to conceptually re-describe one same entity and, thus, allow them to switch more flexibly between rules in the DCCS. The experience that the same referent has a completely different label in another language might also underlie L2-learners' advantage in the DT. The understanding that objects and labels do not have a one-to-one mapping, along with the ability to use synonyms for the same referent, has been shown to be linked to children's understanding that other people may not have the same knowledge about a situation (Perner & Doherty, 1998; Perner & Lang, 2002). Doherty and Perner (1998; 2020) suggested that the ability to name an object with different labels and the ability to consider others' points of view is underpinned by a same understanding of the concept of perspective, i.e. by the ability of linking different co-referential representations. Therefore, it might be that the experience of naming things in another language for the first time promoted L2-learners' co-representational abilities, which would favour their advantage over the non L2-

learning group both in the DCCS an DT.

We acknowledge the limitation that we were not able to control for possible differences between schools in terms of teaching approaches or general educational environment. However, as schools are required to conform to the standards set by the Education Department and undergo regular inspections by the Office for Standards in Education, fundamental differences in quality of teaching or consideration for children's well-being are not very likely. In addition, potential differences in quality of teaching across the three participant groups were lessened by the fact that none of the groups relied on a single school.

To conclude, we found that L2 learning at its very early stage impacts cognitive flexibility and perspective taking but has no remarkable effect on attentional skills. To our knowledge, this is the first study that investigated the cognitive advantages of L2 learning not only in bilingual immersion programs but also in mainstream education. Therefore, it is a first important evidence that introducing L2 in mainstream schools' curriculum from early years can enhance children's flexible thinking and promote their socio-communication skills. Further research should focus on investigating if the initial advantages we found are maintained in successive years of school.

CHAPTER 3
DOES EARLY SECOND LANGUAGE LEARNING AT SCHOOL ENHANCE FLUENCY AND FLEXIBILITY DURING CREATIVE PRODUCTION?

3.1 Introduction

Creativity, like bilingualism, is a multifold concept. It defies a unique definition. A common view links creativity with originality in artworks or ingenuity in inventions and it is generally thought as a peculiar innate trait of big historical personalities (Simonton, 2008). Defining creativity for research purpose is difficult (Torrance, 1993). As Simonton (2008) pointed out, a useful definition of creativity for psychometric research is Guildford's (1967) definition of divergent thinking, namely the ability to produce multiple solutions to the same problem. In this chapter, the terms creativity, creative thinking and divergent thinking will be used broadly in this latter meaning. I will review the studies which explored the impact of bilingualism and second language learning on creative thinking. I will then present an experiment conducted as part of the longitudinal study reported in Chapter 2.

Guildford (1967) identifies four dimensions of divergent thinking: fluency, flexibility, originality and elaboration. Fluency of thinking enables to generate a large number of ideas to solve a problem, while flexibility is characterized by the ability of shifting between categories when generating solutions. For example, when being asked to enumerate different possible uses of a brick, someone might produce only similar responses such as "build a house, build a school, build a store, build a wall, etc." (Guildford, 1967, p. 143). This shows a high degree of fluency, but no flexibility. High level of flexibility, in turn, is shown when responses pertain to several different categories, such as "build a house, make a doorstop, make red powder, write a message, etc." for the "brick" example (Guildford, 1967, p. 143). Furthermore, originality is the generation of rare, or unique, responses, while elaboration is the ability of refining ideas by

adding details (Guildford, 1967).

Although there is evidence that bilingualism has a positive impact on creative thinking (for reviews see Ricciardelli, 1992b; van Dijk et al., 2019; but see Lange et al., 2020), not all aspects of creativity seem to be equally affected (Leikin et al., 2014). Leikin et al. (2014) administered three different creativity tests to bilingual and monolingual preschoolers, namely the Pictorial Multiple Solution task (PMS; Leikin, 2013), which assesses problem solving abilities in everyday situations, the Creating Equal Number task (CEN; Tsamir et al., 2010), which assesses mathematical creativity, and the figural form of the Torrance Test of Creative Thinking (TTCT; Torrance, 1966), which assesses figurative creativity. The PMS presents children with a picture of a humanized kitten who is trying to get their hat hanging on a peg too high for them to reach. Other objects and furniture are included in the picture. Children are asked to come up with as many ways as possible in which the kitten can get their hat. The CEN presents children with ten identical bottle caps sorted in two groups. One group consists of three bottle caps and the other of seven. The child participant is asked to find different ways of making the two groups equal in number. The figural TTCT has three subtasks and requires children to a) produce drawings starting from a single shape, a teardrop or a bean shape (in the "picture construction" task), b) finishing a series of different incomplete figures ("picture completion" task), or c) making multiple pictures using a same repeated circle or pair of parallel lines ("repeated figures" task; Said-Metwaly et al., 2018). Responses in the tasks were scored under the four components of divergent thinking, i.e. fluency (number of valid responses), flexibility (number of categories the responses belong to), originality (inverse frequency of the response within the cohort) and elaboration (number of detail given in the response). Bilinguals and monolinguals performed equally in the PMS, showing that the two groups did not differ in the ability to solve a common problem. However, bilinguals showed better performances in the

CEN, where they recorded higher level of flexibility and originality, and in the figural TTCT, where a more pronounced bilingual advantage was recorded in the flexibility scores of the "repeated figures" subtask.

The ability of thinking flexibly and linking different conceptual representations seems to be enhanced in bilingual children from a very early age. Adi-Japha and colleagues (2010) asked a group of 4-year-old monolinguals and a group of same-aged bilinguals to draw "a flower that does not exist". Monolinguals tended to depict flowers with missing or modified components, e.g. "a flower without a stalk" or "a flower with just one petal", while bilinguals were better able to integrate different categories in their drawings by producing, for example, "a giraffe flower" or "a flower with arms and legs". The same pattern of results was found in monolingual and bilingual 5-year-olds asked to draw non-existent houses (Adi-japha et al., 2010). While bilinguals and monolinguals did not differ in the number of intrarepresentational modifications (i.e. size changes or elements deletion within a same representation), bilinguals showed more interrepresentational (or cross-category) changes in their drawings as compared to monolinguals. The researchers suggested that bilinguals' cross-category flexibility might derive from their familiarity of navigating a more complex network of conceptual association which stems from the integration of two linguistic systems.

The notion that shifting between different linguistic systems may enhance creative thinking is related to the suggestion that enhancement in creative thinking depends on the degree of bilingualism (Kim, 2011; Lee & Kim, 2010; Ricciardelli, 1992a) and that a high degree of proficiency in both languages is needed to have an impact on creativity development (Ricciardelli, 1992b). Ricciardelli (1992b) compared differently balanced English-Italian 5-and 6-year-olds bilinguals to same-aged English monolinguals in the Thinking Creatively in Action and Movement test (TCAM; Torrance, 1981), a measure of creativity where responses are

kinesthetic instead of pictorial or verbal (in one of its subtasks, for example, children are asked to move around in as many different ways as possible; Zachopoulou et al., 2009) and found that bilinguals with a high degree of proficiency both in Italian and in English recorded higher fluency scores as compared to both high-proficient English monolinguals and unbalanced bilinguals highly proficient in English. No significant differences were found between the latter two groups. More recently, Lee and Kim (2011) administered the figural TTCT to 116 Korean American bilinguals (age ranged from 7 to 18, with a mean of 11) and found that, while age was not related to creative abilities, the degree of bilingualism was, with more balanced bilinguals having higher creativity scores.

In line with the view that balanced bilingualism supports creative thinking, Leikin (2013) suggested that bilinguals' enhancement in creativity development needs to be sustained by a balanced education in both languages. The researchers compared two groups of 3.5-year-old Hebrew-Russian bilinguals in Israel, one group attending a bilingual Hebrew-Russian kindergarten and the other attending a mainstream monolingual kindergarten, with a group of same-aged Hebrew monolinguals in mainstream education on the PMS and CEN tasks. Measurements were taken twice, 12 months apart. There were no differences between the three groups at the first testing point in either measure. At the second testing point, the two bilingual groups did not differ in any of the measures. However, as compared to monolinguals, the bilingual group in bilingual education showed a more consistent advantage across the tasks. In the CEN, both groups of bilinguals performed better than monolinguals in originality and composite creativity, but only bilinguals who attended the bilingual kindergarten were superior to monolinguals in fluency and flexibility. Moreover, in the PMS, only bilingual children in bilingual education outscored monolinguals in originality and composite creativity.

In contrast to studies with children, studies on young adults have recorded less consistent

results with regards to the effect of language proficiency (van Dijk et al., 2018). While Kharkhurin (2011) found that high-proficient bilingual college students outperformed their low-proficient bilingual counterparts in measures of divergent thinking, Hommel et al. (2011) reported a low-proficient bilingual superiority over high-proficient bilinguals for fluency. In turn, high-proficient bilinguals were superior to low-proficient ones in measures of convergent thinking (Hommel et al., 2011), defined as the ability to focus on a single best-fit solution (Guildford, 1967). In other words, while low-proficient bilinguals were better in tasks requiring them to generate a large number of ideas, high-proficient bilinguals were better in tasks demanding to find the one possible answer (e.g. finding the link between three given concepts, such as finding that "long" connects "hair", "stretch" and "time"; Hommel el al., 2011). According to Hommel and colleagues (2011), enhanced selective attention would support high-proficient bilinguals in convergent thinking but would not be advantageous in divergent thinking production. However, contrary to what Hommel et al. (2011) found, a recent study by Leikin et al. (2020) which compared young balanced and unbalanced bilingual adults in divergent and convergent thinking, recorded higher scores for balanced bilinguals in both measures.

Studies have also investigated the relationship between creativity, bilingualism and EFs. Leikin et al. (2020) tested participants not only on divergent and convergent thinking, but also on EF measures. They found no relationship between EF scores and either divergent or convergent thinking scores. A recent study by Sampedro and Peña (2019) on 224 preadolescent Basque-Spanish bilinguals revealed that the relationship between creativity, level of bilingualism and EFs might be more complex. Participants were divided into three groups according to their degree of bilingualism, namely high-, medium- and low-proficient bilinguals, and were administered tasks of verbal and figural divergent thinking along with measures of EFs (general cognitive flexibility and selective attention). High-proficient bilinguals outperformed medium-

proficient ones in divergent thinking (both verbal and figural) and general cognitive flexibility measures but, compared to low-proficient bilinguals, high-proficient bilinguals were superior only in figural creativity. Notably, low-proficient outperformed medium-proficient in general cognitive flexibility and verbal originality. No difference between the three groups was found in selective attention. Cognitive flexibility was found to be the mediating factor between level of bilingualism and creativity, with both high- and low-proficient bilinguals recording higher scores in cognitive flexibility associated with higher creativity scores.

Enhancements in creative thinking have been recorded not only for bilinguals who acquired their languages in natural settings but also for those whose second language knowledge was acquired through foreign language classes (Ghonsooly & Showqi, 2012; Landry, 1973a, 1973b). Monolingual Persian teenagers who had learnt English as a foreign language (EFL) and achieved an advanced proficiency in English, outperformed same-aged non-EFL learners in all components of the TTCT (Ghonsooly & Showqi, 2012). Early research on children receiving foreign language classes in Elementary schools (FLES) in the United States recorded advantages in divergent thinking for children in higher grades (Landry, 1973a; 1973b). Landry (1973a) tested second, fourth and sixth graders on the figural TTCT. Participants were divided into two groups: one group was attending a school with a FLES program (i.e. a foreign language was taught weekly; Stewart, 2005) while the other was attending a school with no foreign language provision. Advantages in fluency and flexibility were found for FLES school children in the fourth grade and above. Second graders (thus "before the second language influence", Landry, 1973a, p. 111) performed comparably in the two schools, showing there was no difference between the two schools participating in the study. Landry's (1973a) results are extremely interesting as they suggest that teaching languages at school can enhance children's divergent thinking. However, the study contains various ambiguities. Firstly, it is not clear how the FLES

provision was structured, not only in regard to the year groups involved, but also in regard to the amount and the length of the weekly classes offered. Therefore, it is difficult to infer the proficiency level in the L2 attained by fourth and sixth graders in the FLES school. Secondly, the initial language status of FLES school children is not specified, nor is the language status of the children in the control group. It might well be that children with a different heritage language (and, therefore, were bilinguals or exposed to another language besides English at home) took part in the study and, if so, children from the two schools might not have matched, neither in initial language status nor in initial divergent thinking ability.

In summary, although there is evidence that acquiring a second language, both in natural and formal settings, supports divergent thinking, results are mixed, especially in regard to the role of proficiency level. Despite early promising results, the impact of foreign language learning in Primary schools on creative thinking has not, to our knowledge, been further investigated since Landry's (1973a; 1973b) studies, and importantly never with the means of a longitudinal study.

The current experiment, conducted as part of the longitudinal research presented in Chapter 2, explores whether creative abilities can be enhanced by learning a new language in the first year of formal education. In order to avoid the ambiguities observed in Landry's (1973a; 1973b) studies, we selected only participants who did not have any previous exposure to a second language, either in formal or informal contexts. All participants were monolinguals from monolinguals households with none (or, presumably, close to none) previous experience of a second language. Furthermore, we investigated the effect of the amount of second language learning. Participants were divided into three groups according to the amount exposure to the new language they received. One group, attending bilingual schools (BilS), had a substantial exposure to a new language, a second group, in mainstream education, had only a very limited

exposure through a weekly short session (WL2), and the third group was not exposed to any additional language (NoL2). We checked children's divergent thinking abilities by administering a modified version of the "repeated figures" task of the figural TTCT at the beginning of the school year and checked their progress by administering it again (but with different stimuli) 24 weeks later.

Considering that low-proficient bilinguals have mainly shown advantages in fluency (Hommel et al., 2011; Landry, 1973a) and flexibility (Landry, 1973a), we expected that children newly exposed to a second language would show enhanced progress in these two dimensions of divergent thinking, with the caveat that a very limited exposure to the new language, as in the group with weekly foreign language classes, might not be advantageous to children's creative development. In addition, in order to check if enhanced switching and selective attention abilities are involved in supporting creative fluency and flexibility, we checked the correlations with Conflict scores from the Attentional Network Task (ANT; Rueda et al., 2009) and with scores on the Dimensional Change Card Sort task (DCCS; Zelazo, 2006), which are, respectively, measures of selective attention and switching presented in Chapter 2. If the superiority in creative fluency or creative flexibility of one of the groups is due to enhanced selective attention or switching abilities, then this superiority would disappear when controlling for Conflict and DCCS scores.

3.2 Method

3.2.1 Participants See Chapter 2.

3.2.2 Design and Procedures See Chapter 2.

3.2.3 Measures

Baseline measures

We used the same baseline measures as in Chapter 2, namely the Background Information Questionnaire, the Coloured Progressive Matrices, and the British Pictures Vocabulary Scale.

Squares/lines task

This a modified version of the "Repeated figures" task from the figural form of the Torrance Test of Creative Thinking (TTCT). The aim of the task is to assess the ability to respond to a repeated stimulus with different ideas. At TP1 children were presented with a landscape-oriented A4 sheet of paper with 18 28x28mm squares arranged in 3 rows of 6 squares (15 mm apart from each other). At TP2 the squares were replaced with 2 3cm-long horizontal parallel lines, with a total of 18 pairs of parallel lines arranged on 3 rows of 6 pairs (18 mm apart from each other). Children were asked to "turn the squares (or the lines) into something else with their drawing". They were given 10 minutes to produce as many different responses as they could. They were told to think of something different every time and to think of something that only they could think of. The experimenter clarified the task by showing another sheet of paper identical to the task sheet with two already drawn responses. The experimenter pointed to the first example response and said: "For example, I turned this square into a house" and, tracing over the drawing with a pencil, continued "I drew a roof here on top, a door, windows… and now it is not a square anymore, it is a house!". Afterwards, the experimenter pointed to the second example and said "Then, I thought of something else and turned this other square into a window. You need to turn each square into something different every time. You have ten minutes to turn as many squares as you can into something else." The same procedure was followed at TP2, presenting children with the first two pairs of lines turned into a butterfly and a

bag, respectively. If children duplicated the examples given or replicated their own responses, the experimenter invited them to find something different for the next square or pair of lines. If children stopped drawing, the experimenter praised the responses that they had already given and encouraged them to find something else to turn the squares/lines into. After each drawing children were asked to say what they drew and, whenever the way they used the stimulant was not evident, they were also asked to explain what the square (or the lines) represented in their drawing. Children's answers were noted by the experimenter. Responses were scored under two components of divergent thinking, i.e. fluency and flexibility, by two scorers (the researcher and a blind scorer) separately. We had 76% agreement at TP1 and 78% at TP2. Differences in scoring were discussed and a final score agreed (reaching 100% agreement). A general rule for accepting or rejecting participants' responses was to determine whether the stimulant had been integrated into the drawing. Given the young age of the children, and their poor fine motor skills, it was sometimes not easy to establish the role of the stimulant in their responses only on the basis of what they drew. Therefore, we also took into account what children said about their drawings. As previously mentioned, whenever the role of the stimulant was not obvious, children where asked "What is the square/are the lines in your drawing?". If children's answers clearly showed that they meant to incorporate the stimulant but failed to do so because of practical inability, then the response was accepted. For example, sometimes children tried to trace over the square to integrate it into their drawing but, not being able to do so, drew a line around it instead. When asked what the square was, they answered that it was a part of the object that they depicted, e.g. the seat of a chair, therefore, the response was counted as valid. Conversely, if children showed that they used the stimulant only as an area to draw in and produced a drawing unrelated to the stimulant, then the response was rejected. Especially at TP1, children tended to draw something inside the squares, for example, one child drew a snowman

inside the square and said that the square was “snow around the snowman”. This response was rejected. For the fluency score, one point was given for each valid response. Plain replication of the examples presented to them or of their own previous responses were not considered as valid. However, sometimes children produced variations of the examples given (e.g. “a haunted house”) or of their previous responses (e.g. “a doll’s face”, “a pirate’s face”, “a dog’s face”, etc.). These were counted for fluency but not for flexibility. As for flexibility, one point was given for each category the responses belonged to. All the variations of an idea were assigned to one category were and thus given one point (e.g. “a doll’s face”, “a pirate face” and “a dog’s face” were assigned to the category “square used as face” and were given three points for fluency but only one point for flexibility). Following Beck et al. (2016) categories were determined unanimously by both scorers who detected recurrent responses across all participants at each testing point. At TP1 the following categories were identified: buildings (such as schools, churches, castles etc.), boxes or containers, nests/homes/shelters for animals/people (which were drawn inside them), squares used as the body of animals/people, squares used as faces for animals/people/monsters, square used as fences/compounds/paddocks to delimitate an area (e.g. garden/parks), stationery (such as cards, photos, papers, pictures), furniture (chairs, tables, cupboards etc.), playground equipment (slides, swings etc.), and vehicles (such as cars, lorries, vans etc.). At TP2 categories were: buildings, boxes or containers, lines used as roads/paths/bases (with someone walking/standing on them or a vehicle driving on it), lines used as the body for animals/people/monsters, stationery, furniture, vehicles, and electronic devices (such as phones/tablets/laptops). Additional categories with single members were established when responses could not be assigned to one of the above-mentioned categories. These responses were given one point for flexibility. The maximum possible score both for Fluency and Flexibility was 18 points.

3.3 Results

As we did for the other tasks of the longitudinal study presented in Chapter 2, Fluency and Flexibility scores were analyzed with the means of a two-way ANOVA, with Testing Point (TP) as a within-subject factor (TP1 vs TP2) and Group as a between-subject factor (BilS, WL2, NoL2). Whenever there was an interaction, TP1 and TP2 scores were analyzed separately with a between-participant one-way ANOVA. In addition, we checked whether any control variable (i.e. age, SES index, passive vocabulary and non-verbal reasoning scores) correlated with the dependent variable of interest (see Table 3.1.2 in Appendix). If any of them did, then we followed up the initial ANOVA with an ANCOVA that included the correlating control variables as covariates.

Furthermore, we checked correlations between ANT Conflict and DCCS scores with both creative fluency and creative flexibility at TP1 and TP2. As for the Conflict, we included in the analysis only participants who reached 60% accuracy in the ANT at TP1 (as we did in Chapter 2). A Conflict composite scores was calculated by transforming Conflict accuracy and Conflict RTs into z-scores and, then, by averaging them (the sign of Conflict accuracy z-scores was reversed before averaging so that low scores would correspond to better performance, while the sign of Conflict RTs z-scores was not reversed as low conflict RTs scores already corresponded to better performance). As for DCCS, all participants were included in the correlation analyses. Table 3.1.1 in Appendix shows means of creative fluency, creative flexibility, DCCS and Conflict composite scores at TP1 and TP2.

3.3.1 Fluency

There was a main effect of TP on Fluency scores, $F(1,96) = 32.6$, $p<.001$, $\eta_p^2 = .253$, but

no effect of Group, F(2,96) =.7, p=.515. The interaction between TP and Group was significant, F(2,96) = 5.4, p =.006, η_p^2= .101. Follow-up analysis revealed that at TP1 the difference between the groups was not significant, F(2, 96)=.3, p=.753, but at TP2 was significant, F(2,96) = 3.1, p =.049, η_p^2= .061 (See figure 3.1). However, as SES was positively correlated with Fluency scores at TP2 (r=.234, n=98, p=.021), we centered the variable and then entered it into an ANCOVA. Controlling for SES led to the same result pattern. There was still a main effect of TP, F(1,94) =32.3, p<.001, no effect of Group, F(2,94) = .4, p=.657, and the interaction between TP and Group was significant, F(2,94) = 5.1, p =.008, η_p^2= .098. Again controlling for SES, we found that the difference between the groups at TP1 was not significant, F(2,94)=.4, p=.651, at TP2 it showed a trend towards significance, F(2,94) = 2.6, p =.077. Follow up comparisons for TP2 revealed that (when controlling for SES) there was no difference between BilS and WL2,

F(1, 58) = 2.7, p=.109, or between WL2s and NoL2, F(1, 63) = .3, p=.585, but there was a significant difference between BilS and NoL2 with a medium effect size, F(1,66) = 4.7, p=.034, η_p^2= .066. We then asked whether the bilingual advantage in creative fluency was due to enhanced EFs. DCCS scores were not related to creative fluency scores at either TPs.

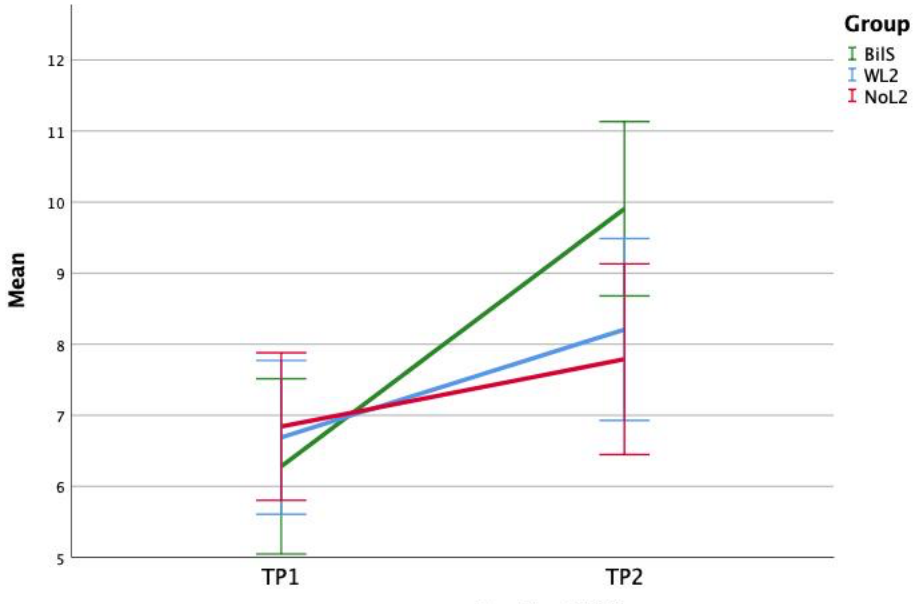


Figure 3.1. Creative Fluency - scores mean by Group at TP1 and TP2

However, Conflict Composite scores significantly correlated with fluency scores at TP2 (r=.234, n=76, p=.042), suggesting that better conflict resolution corresponded with lower fluency. We thus added the Conflict composite scores as a covariate into an ANCOVA in order to check if the differences between the groups were accounted for by selective attention, but we reduced the participant sample to only those who scored above chance in the ANT (i.e. reached at least 60% accuracy at TP1). For these participants, SES was not related to fluency scores and was therefore not added as a covariate. An ANOVA without the covariate revealed the same pattern as for the whole participant group, namely a significant main effect of TP, $F(1, 73) = 25.7$, $p<.001$, $\eta_p^2= .261$, no effect of Group, $F(2, 73) = 1.1$, $p = .335$, and a significant interaction between TP and Group, $F(2, 73) = 4.1$, $p=.021$, $\eta_p^2= .101$. Follow-up analyses revealed again that groups did not differ at TP1, $F(2, 73)=.2$, $p=.790$, but at TP2, $F(2, 73) = 3.4$, $p=.037$, $\eta_p^2= .086$. A Bonferroni post hoc test revealed that at TP2 there was a significant difference between BilS and NoL2 ($p=.046$), but there was no significant difference between BilS and WL2 ($p=.161$) or between WL2 and NoL2 ($p=1.000$). An ANCOVA with Composite Conflict at TP2 as covariate revealed the same pattern of the ANOVA, namely a significant main effect of TP, $F(1, 72) = 25.6$, $p<.001$, $\eta_p^2= .262$, no effect of Group, $F(2, 72) = .8$, $p = .478$, and a significant interaction between TP and Group, $F(2, 72) = 3.5$, $p=.035$, $\eta_p^2= .089$. An ANCOVA on Fluency scores at TP2 with Composite Conflict at TP2 as covariate revealed a trend towards significance for the difference between the groups, $F(2, 72)=2.7$, $p=.076$, $\eta_p^2= .069$. Follow-up comparisons revealed that, after accounting for selective attention, at TP2 the difference between BilS and WL2 was trending towards significance, $F(1,47)=3.7$, $p=.062$, $\eta_p^2= .072$, the difference between BilS and NoL2 was significant with a medium to large effect size, $F(1,49)=4.3$, $p=.044$, $\eta_p^2= .080$, but there was no significant difference between WL2 and NoL2, $F(1, 47)=.0$, $p=.855$.

3.3.2 Flexibility

For flexibility scores, there were main effects of TP, $F(1,96) = 29.4$, $p<.001$, $\eta_p^2= .234$, and of Group, $F(2,96) =7.0$, $p=.001$, $\eta_p^2= .128$, as well as an interaction between TP and Group, $F(2,96) = 6.3$, $p =.003$, $\eta_p^2= .116$ (see figure 3.2). As BPVS was positively correlated with flexibility scores at TP1 ($r=.245$, $n=99$, $p=.014$) and SES was positively correlated with flexibility scores at TP2, we centered the two variables and entered them as covariates into an ANCOVA. The pattern of results remained the same as in the ANOVA. The main effects of TP, $F(1,93) = 29.5$, $p<.001$, $\eta_p^2= .241$, and of Group, $F(2,93) =6.8$, $p=.002$, $\eta_p^2= .127$, were still significant, and so was the interaction between TP and Group, $F(2,93) =6.1$, $p=.003$, $\eta_p^2= .116$. Follow-up analyses (with BPVS and SES as covariates) revealed that the difference between groups at TP1 was not significant, $F(2, 93)= .4$, $p=.700$. At TP2, however, the difference between the groups was significant, $F(2,93) =9.3$, $p<.001$, $\eta_p^2= .167$. Follow-up comparisons (with BPVS and SES as covariates) for TP2 showed that BilS had significantly higher flexibility scores than both WL2, $F(1,57) =5.1$, $p=.028$, $\eta_p^2= .082$, and NoL2, $F(1,65) =16.8$, $p<.001$, $\eta_p^2= .206$, while WL2s' and NoL2s' scores showed a trend towards significance, $F(1,62) =3.8$, $p=.057$, $\eta_p^2= .057$ with WL2s tending to have higher flexibility scores than NoL2s with a small to medium effect size.

We then asked whether the bilingual advantage in flexibility in creativity was due to enhanced EF. In Chapter 2 we found that (after controlling for passive vocabulary) at TP2 BilS were superior to both the other two groups in the flexibility measure of DCCS, and WL2 revealed higher DCCS scores than NoL2. Therefore, we checked whether DCCS scores correlated with Flexibility scores. We found that DCCS scores at TP2 were positively correlated

with Flexibility scores at TP2 (r=.332, n=99, p=.001), suggesting that flexibility in creativity is related to general cognitive flexibility. The Conflict Composite scores of the ANT were not related to flexibility in creativity at either TPs. In order to see whether general cognitive flexibility could explain the bilingual advantage in flexibility in creativity, DCCS scores at TP2 were added as a covariate into an ANCOVA with BPVS and SES. After controlling for BPVS, SES and DCCS at TP2, the pattern of results changed, there was still a significant difference in Flexibility between the Groups, $F(2, 92)=4.1$, $p=.020$, $\eta_p^2= .082$ but follow-up comparisons revealed that, after controlling for passive vocabulary, SES and general cognitive flexibility, the difference between BilS and WL2 was not significant anymore, $F(1,56)=2.1$, $p =.153$, $\eta_p^2= .036$, but the difference between BilS and NoL2 was still significant, $F(1,64)=7.0$, $p=.010$, $\eta_p^2=0.98$ with a medium to large effect size. There was again no significant difference between WL2s and NoL2s, $F(1,61)=2.2$, $p=.143$.

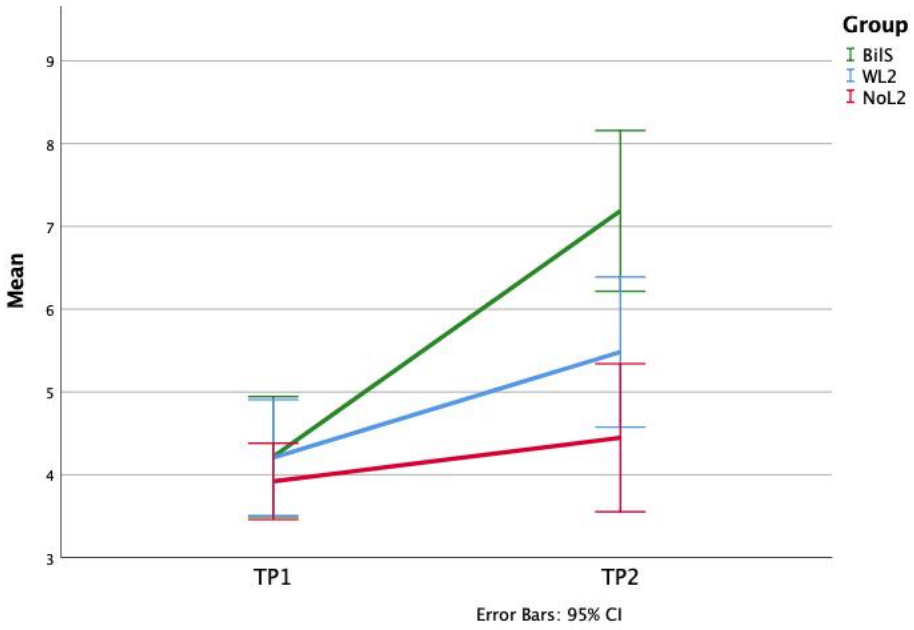


Figure 3.2. Creative Flexibility - scores mean by Group at TP1 and TP2

3.4 Discussion

The present experiment explored the impact of learning a second language at school on two dimensions of divergent thinking, namely fluency and flexibility. We also investigated the interplay of the amount of L2 exposure and EFs on these two components of creative thinking. Three groups of monolingual children who had different amounts of exposure to a new language performed a modified version of the TTCT repeated figures task, a task of general cognitive flexibility (the DCCS) and a task of selective attention (the ANT) at their entrance of formal education and 24 weeks later.

We found that learning a second language in formal settings can enhance creative fluency and flexibility, provided that children are exposed to the new language for a considerable amount of time. At the first testing point the groups did not differ in creative fluency or creative flexibility. At the second testing point children who attended bilingual schools recorded higher scores, both in creative fluency and creative flexibility, as compared to children who did not receive any foreign language provision. However, children in mainstream schools who were learning a new language once a week did not significantly differ from the control group of non L2-learners, suggesting that a limited weekly exposure to a new language might not be sufficient to affect children's creative thinking.

Our findings are in line with a considerable body of literature which found a bilingual advantage over monolinguals in creative fluency (Leikin, 2013; Leikin et al., 2014, 2020) and flexibility (Adi-japha et al., 2010; Carringer, 1974; Kharkhurin, 2008, 2017; Leikin et al., 2014) and with studies which compared L2-learners to a non-L2 learning control group (Ghonsooly & Showqi, 2012; Landry, 1973b, 1973a). Considered that, unlike Landry (1973a; 1973b), we checked participants' initial language status and divergent thinking ability, our results give stronger evidence that foreign language learning in Primary school promotes children's divergent thinking. As we examined children in their first year of formal education and at the

beginning of their L2 learning journey, our study also clarifies that enhancement in divergent thinking is developed in early years of school and during the early stage of L2 learning. Thus, it is not only achieved in higher grades of school or in more advanced stages of L2 acquisition, as Landry's (1973a; 1973b) studies seem to suggest (but note ambiguities in those studies).

Even though we cannot precisely quantify how much L2 exposure is needed to gain advantages in divergent thinking from our experiment, we can, nonetheless, conclude that one weekly session of L2 over half a year has too little effect and does not result in significant changes. At TP2 the scores of children who had a weekly limited exposure to a second language fell in between those of the two other groups, without clear distinctions between the groups. At TP2 weekly language learners showed a numerical advantage over no-exposure children in both divergent thinking measures, but this did not reach significance. Similarly, while weekly language learners' fluency scores at TP2 were numerically smaller than those of bilingual school children, this difference did not reach statistical significance. When general cognitive flexibility was accounted for, also scores in creative flexibility were comparable between the two groups of L2 learners. These results raise the possibility that weekly language learners' creative fluency and flexibility was supported by their exposure to the new language, but a higher amount or a longer time period of exposure might be needed to significantly impact creative thinking.

As for the role of EFs, our results back the idea that EFs play a role in divergent thinking (Beaty et al., 2014; Benedek et al., 2012, 2014; Krumm et al., 2018; Zabelina et al., 2019). Like previous studies (Kharkhurin, 2011; Krumm et al., 2018; Pan & Yu, 2018; Sampedro & Peña, 2019), we found that EFs and divergent thinking abilities are related. However, our results are only partly in line with the suggestion that enhanced EFs explain the bilingual advantage in creativity tasks (Hommel et al., 2011; Kharkhurin, 2011; Sampedro & Peña, 2019). While we found that general cognitive flexibility was positively correlated with creative flexibility scores

and explained the difference in creative flexibility between bilingual school children and weekly language learners, it failed to explain the difference in creative flexibility between bilingual school children and non L2-learners. Furthermore, although weekly language learners performed better than non-exposed children in the DCCS at TP2 (after passive vocabulary and non-verbal reasoning were controlled for), the advantage was not mirrored in creative flexibility performance, where the two groups recorded statistically comparable scores. This suggest that general cognitive flexibility alone cannot account for bilingual school children's improvement in divergent thinking at TP2 and does not explain their advantage over non L2-learners.

As for the relationship between selective attention and fluency, we had to reduce our analysis to a subgroup of participants (i.e., those who performed above chance in the ANT). Within this subgroup, we found a negative relationship between the level of selective attention and fluency of thinking, indicating that those participants who showed weaker conflict resolution skills in the ANT were more fluent in generating ideas in the creativity task. This finding supports the suggestion that divergent thinking is facilitated by a weak top-down control, which allows the mind to wander through unrelated thoughts and, thus, to generate multiple ideas (Hommel et al., 2011). The analyses of fluency scores of the subgroup of children which scored above chance in the ANT showed the same pattern of results as for the whole group: At TP2, children in bilingual education did not differ from weekly L2-learners but outscored the no-exposure group. No difference was found between these two latter groups who attended mainstream education. When we accounted for selective attention, the pattern remained unvaried, indicating that selective attention could not explain the group differences. Therefore, although EFs might have an important role in divergent thinking production, they did not explain the difference between bilingual school children and no-exposure children at TP2.

The most important result of our study is that divergent thinking development was

enhanced in children who attended bilingual schools as compared to those who did not receive L2 classes. The results of our longitudinal study corroborate earlier findings of the impact of L2-learning in Primary school settings on divergent thinking skills (Landry, 1973a; 1973b).

The finding that bilingual school children's superiority in creative thinking could not be explained by enhanced selective attention (as the group did not show superiority in Conflict ANT scores) or by increased general cognitive flexibility, speaks against an EF account of the bilingual creativity advantage (Hommel et al., 2011; Kharkhurin, 2011; Lee & Kim, 2011; Leikin et al., 2014; Sampedro & Peña, 2019). But bilingual enhanced divergent thinking ability has also been explained by their richer and more elaborate conceptual and semantic networks (Adi-japha et al., 2010; Kharkhurin, 2017). Kharkhurin (2017) showed that bilinguals' enhanced flexibility in creative production is linked to the fact that semantic networks in bilinguals connect words that are semantically unrelated for monolinguals. Consequently, due to a mechanism of spreading activation, a particular word would lead to more conceptual associations in bilinguals and would thus facilitate bilinguals' flexible, cross-category, thinking. It is possible that our group of children in bilingual education, being taught for approximately half of the school time in a foreign language, had already enriched their networks of conceptual associations.

Alternatively, bilingual school children's increased abilities in divergent thinking might have been prompted not only by their encounter to a new language but also by their exposure to a bi-cultural or, as in the case of one of the bilingual schools of our studies, to a multi-cultural environment. There is evidence that experience of culturally diverse environments leads to creativity enhancements (Gocłowska & Crisp, 2014) and that cultural diversity in school settings favors children's divergent thinking (Vezzali et al., 2016). As we strictly limited the participation in our study to children from English monolingual households and most parents'

background was British (only five parents came from English- speaking countries outside UK), our participants' home environment was largely monocultural. It is very likely that bilingual schools, with staff and teachers that are native speakers of non-English languages, offered children a very first experience of a new culturally diverse context. This experience might have played a key role in their divergent thinking development.

We acknowledged the limitation that divergent thinking skills in our experiment were measured through one task only. By administering multiple tasks of divergent thinking, we would have been able to check the internal consistency of the paradigm. The TTCT (both the verbal version and the figural one), for example, consists of different divergent thinking tasks, which increases the reliability of the scores. However, in the literature the scoring criteria of divergent thinking tasks are rarely reported, making it difficult to compare results between different studies.

In conclusion, our study gives important evidence that second language immersion programs at school foster fluency and flexibility of thinking. Our findings clarify that advantages in creative thinking are achieved in early stages of L2 learning, provided that children receive L2 instructions for a considerable amount of time, and not just for one limited session once a week. Increased progress in divergent thinking was not entirely explained by EFs. Therefore, we speculate that during the first six months of school, bilingual school children might have developed an enriched lexical-semantic network. This system of more elaborate semantic associations might derive from the acquisition of a new language and/or exposure to a new culturally diverse environment. As our research cannot quantify the minimum amount of L2 exposure needed to boost creative thinking. Further studies should focus on this aspect and consider whether increasing the amount of L2 exposure in mainstream schools could positively impact children's divergent thinking skills.

CHAPTER 4
INHIBITORY CONTROL OR SOCIAL SKILLS? TWO ACCOUNTS FOR A BILINGUAL ADVANTAGE

4.1 Introduction

Results in Chapter 2 support the notion that an early exposure to a second language improves children's perspective taking in communicative settings (Fan et al., 2015; Liberman et al., 2017). This ability is part of a larger literature on the bilingual advantage in perspective taking (see review in Barac et al., 2014; and a meta-analysis in Schroeder, 2018), that is the ability to understand that other people have knowledge, beliefs, intentions and desires that can differ from one's own. Perspective taking (PT) is also known as mindreading or Theory of Mind (ToM). It is still unclear what the exact reason is behind the bilingual advantage in perspective taking and whether the reason is the same in all perspective taking tasks. The present study will address potential reasons of perspective taking in a communicative task.

Development in ToM occurs between the ages of two and seven, with a dramatic spurt between the ages of three and four (Apperly, 2011). In a typical ToM False Belief task, the unexpected transfer task (Wimmer & Perner, 1983), children are presented with a situation where a character stores a piece of chocolate in a place, but, in their absence, another character moves the chocolate to another location. Children are then asked to predict where the first character would look for the chocolate when they return to the scene. Three-year-olds usually fail to consider that the other person does not share their knowledge of the situation (i.e. that the chocolate has been moved) and predict that the character would look for the chocolate in the new location. The ability to answer the question from the naive person's point of view is usually reached at four years of age (Wellman & Liu, 2004)

There is evidence that bilingual children acquire perspective taking skills precociously (for a review see Barac et al, 2014; see Schroeder, 2018 for a meta-analyses; but see Dahlgren et

al., 2017; Kyuchukov & De Villiers, 2009). The origin of the bilingual advantage is unclear. The two most commonly suggested explanations are an EF account and a social-pragmatic account.

According to the EF account, the bilinguals' superiority in ToM tasks is due to their enhanced EF skills (Bialystok & Senman, 2004; Goetz, 2003; Kovács, 2009). This idea is grounded on a robust body of research which showed that performance in ToM tasks and performance in EF tasks are related (Carlson et al., 2002; Carlson & Moses, 2001; Perner & Lang, 1999). However, the relationship between ToM and EFs is difficult to disentangle, as both areas of cognition show similar developmental time trajectories. While for some researchers development in EFs enables children to express preexistent ToM abilities (expression account), for others EFs are decisive for ToM abstract concepts to be constructed (competence account) or for ToM reasoning to be initiated (emergence account; for a meta-analyses see Wellman et al., 2001). Despite disagreement on the role of EFs in ToM development, it is generally recognized that classic ToM tasks rely on EFs to be performed (Call & Tomasello, 1999). For example, in the unexpected transfer tasks, children have to monitor the events, infer the naive character's belief, hold two contrasting mental states in mind (the character's false belief and their "informed" one) and, finally, inhibit their own knowledge of the situation to give an answer from the character's point of view (Apperly, 2011, p. 23).

In particular, early studies on bilingual ToM skills interpret their results in line with the EF account (Bialystok & Senman, 2004; Greenberg et al., 2013; Kovács, 2009). Kovács (2009) set to investigate whether experience of communication failures due to code-misalignment or EFs are crucial in bilinguals' ToM superiority. The researcher compared Romanian-Hungarian two- and three-year-old bilinguals to same aged Romanian monolinguals on two different versions of the unexpected transfer task: a standard version and a variant that presented a language-switch situation. The standard version was a classic False Belief task (see 'chocolate'

example above). In the modified version, two characters, a Romanian monolingual and a Romanian-Hungarian bilingual, wanted to buy an ice-cream. Two stalls were on the scene, an ice-cream stall and a sandwich one. The two characters go to the ice-cream stall but there is no more ice-cream left. The ice-cream vendor tells them in Hungarian (= language switch) to go to the sandwich stall, as there was still some ice-cream on sale there. Participants were asked to say where the monolingual character (who did not speak or understand Hungarian) would go to buy the ice-cream. The demands posed on EFs were comparable in both tasks, but the two versions presented different levels of difficulties to the two participant groups in terms of experience. Bilinguals are more accustomed to the language-switch version than to the classic one and might therefore outperform monolinguals only in this version of the task. Bilinguals outperformed monolinguals in both conditions but performed comparably in both versions of the task. Therefore, Kovács (2009) concluded that crucial for bilinguals' success in ToM tasks were their enhanced EFs and not their previous experience of miscommunications, which would have enabled them to perform better in the code-switch version of the task.

Another study proposing an EF account of the bilingual ToM advantage explored the bilingual advantage in the Appearance-Reality task (Flavell et al., 1983). In this task, children are presented with an object that looks like something else, e.g. a sponge that looks like a rock, and are asked what it is (children usually answer on the basis of the object's appearance, e.g. "a rock"). After children are shown that, in fact, the object is deceptive (it is not a rock but a sponge), they are asked three questions, namely what they thought the object was when they first saw it, what a friend or a puppet who was not in the room would think the object is if they see it, and, finally, what the object really is. Bialystok and Senman (2004) pointed out that while the first two questions pertain to the appearance of the object, i.e. its perceptual traits, the last one concerns the reality of the object, i.e. its functional properties. The researchers further reasoned

that in the reality question EFs are crucial, as children have to resolve the conflict between the perceptual and the functional features of the object. However, representational abilities, and not EFs, are decisive in the appearance questions, as the mental representation of the object is initially constructed on the basis of its perceptual characteristics. Bialystok and Senman (2004) presented the tasks to monolinguals and bilinguals aged 4 to 5 and found a bilingual advantage in the reality question only. Therefore, the researchers concluded that enhanced EFs, and not superior representational ability, accounted for the bilingual advantage in ToM. In line with the EF account, Greenberg et al. (2013) suggested that bilingual EFs superiority could be crucial in a visual perspective-taking task where 8-year-old bilinguals were found to be better able than their monolingual peers at judging how a character saw a display of blocks when he moved in positions which did not match their own.

A major limitation of these early studies that propose the EF account of the bilingual ToM advantage is the lack of direct evidence. No measure of EF was administered in the above-mentioned studies, which were conducted at a time when a bilingual advantage in EFs was consistently documented and not very much doubted. The bilingual EF advantage has lately been questioned (e.g., de Bruin et al., 2015; Paap et al., 2016, 2017) as previous findings have sometimes not been replicated (e.g., Antón et al., 2014; Paap & Greenberg, 2013). If bilinguals do not have an EF advantage, then enhanced EF cannot explain a bilingual advantage in ToM tasks.

More recent studies have casted doubt on the EF account of the ToM advantage. It has been found that EFs are crucial to monolinguals' performance in False Beliefs Tasks, but do not play a critical role for bilinguals (Diaz & Farrar, 2018a, 2018b). For instance, Diaz and Farrar (2018a) compared a group of bilingual preschoolers to a group of same-aged monolinguals in a series of False Beliefs, EF and language proficiency tasks. Both groups' performance in False

Beliefs tasks was predicted by language proficiency (which was higher for the monolingual group). After controlling for language proficiency, bilinguals showed a superiority in False Beliefs Task. EF abilities did not predict bilinguals' performance in ToM tasks. In contrast, inhibitory control was found to be a related to monolingual ToM performance.

A bilingual advantage has also been found in PT tasks with lower EF demands, suggesting that the bilingual PT advantage in tasks that have a strong EF component might not stem from an EF advantage either. For instance, young bilinguals are better able to attune the way they communicate to the needs of an interlocutor. Gampe et al. (2019) observed 110 three-year-olds interacting with two different puppets, a ladybird and a grasshopper, during a hide and seek game. The puppets had to find the pieces of a puzzle that had previously been hidden under other toys with the help of the child. While one puppet, the ladybird, was happy to receive help, the other, the grasshopper, expressed disappointment when help was offered. Bilingual children were better able at modulating the way they conveyed information according to the puppet's desire to be assisted. More specifically, all children helped the two puppets equally, however, bilingual children helped the grasshopper less overtly (i.e. instead of verbally indicating the location, they, for example, silently lifted the toys where the pieces were hidden) as compared to how they helped the ladybird. Monolingual children were not as good as bilinguals in adapting their communication to the grasshopper's need and openly suggested the location of the pieces to both puppets comparably.

In contrast to the EF account of the bilingual advantage in ToM tasks, the socio-pragmatic account suggests that the advantage derives from experience with communicative situations where interlocutors do not share the same linguistic system, as misunderstanding are more likely to occur. Frequent exposure to miscommunications and subsequent need to repair communication breakdowns would favour bilinguals' superior pragmatic skills (Fan et al., 2015;

Liberman et al., 2017; Wermelinger et al., 2017). Along with more opportunities for misunderstanding and clarification requests, a multilingual context forces children to constantly track which language is used by whom in order to code-switch and align effectively with their interlocutors. This might elicit an earlier understanding that individuals can have different knowledge and perspectives, boosting bilingual children's social cognition (Goetz, 2003).

Children raised in multilingual households indeed develop a very early sensitivity to different speakers, as they are able to selectively use their languages according to interlocutors' as early as two years of age (Nicoladis & Genesee, 1996). This particular socio-pragmatic ability, defined as pragmatic differentiation, has been found to be related to performance in ToM task. Tare and Gelman (2010) tested a group of bilingual pre-schoolers and reported an association between bilingual performance in ToM and their ability to adjust their language to the language of different experimenters during an object naming task. Interestingly, no association was found between the same children's ToM performance and their pragmatic differentiation skills during free play, where both low and high performers in ToM tasks showed a comparable ability to tune their language with different interaction partners.

Other evidence of a link between bilingual socio-pragmatic ability and ToM stems from a study by Cheung et al. (2010) with Cantonese-speaking young learners of English. Children's socio-pragmatic ability was assessed by recording their promptness in switching language according to the interlocutor's verbal reaction to a greeting. Children who were quicker at adjusting their greetings to the interlocutor's language were also better in ToM tasks.

In line with the socio-pragmatic account, young bilinguals have shown superiority in diverse pragmatic skills which has been explained by their substantial experience of challenging communication in multilingual contexts. In a referential communication game, the Director task (Fan et al., 2015), a group of children merely exposed to a multilingual environment were as

good as bilinguals at interpreting instructions from the point of view of a communication partner, with both groups outperforming their monolingual counterparts. The EFs account was dismissed on the basis of an unequal performance of bilingual and children exposed to another language in a measure of EFs. More precisely, while in the Director Task bilinguals and children exposed to another language recorded comparable scores in the DCCS, exposed children were not as good as bilinguals and performed similarly to monolinguals. Therefore, Fan et al. (2015) suggested that bilingual enhanced perspective taking ability is social in origin and not related to superior EFs. Instead, they argued that children's experience of a multi-language environment enhances their perspective taking abilities, in line with the socio-pragmatic account of the bilingual PT advantage.

Fan and colleagues'(2015) conclusion is based on one type of EFs (the DCCS), namely switching ability. But evidence suggests that switching ability is not the most relevant ability in the Director task. Nilsen and Graham (2009) tested 4- and 5-year-olds in a simplified version of the Director Task and various measure of different EF components and found that only conflict inhibition, and not switching or WM, correlated with non-egocentric responses. Further evidence that switching is not central in the DT comes from a study with adults. (Apperly et al., 2010) devised a modified version of the DT, in which participants had to constantly shift between the perspectives of two different directors: an "informed Director", who shared the participants' privileged angle, and an "ignorant Director" with the usual, limited view on the display. Apperly and colleagues (2010) found that the rate of egocentric error did not vary between conditions, hence they concluded that the difficulty in the DT is not determined by switching demands. Thus, in order to rule out that the bilingual advantage in the Director Task is due to an EF advantage, it is important to test participants on a switching task.

The importance of EF abilities in the Director task, in particular inhibition abilities, is

evident in a study by Epley et al. (2004), who recorded adults' and children's eye movements during the DT and found that adults directed their first look to distractor objects in privileged ground as often as children. Children, however, committed more egocentric errors as compared to adults. Therefore, the researchers concluded that adults and children differ in the ability to adjust their initial self-centered decoding. Adults would be better able to control their behaviour over their earliest interpretation, while children, less able to overcome their first look, would make more egocentric mistakes. Thus, adults' performance seems to be driven by their superior inhibition ability.

The present study addressed the reason for young bilinguals' enhanced perspective taking ability in referential communication, that is in the Director Task. It investigated whether the advantage stems from enhanced inhibitory control or from superior social skills. We recruited a group of monolingual and a group of multilingual (bi- and trilingual) children aged 4 to 7 and compared their performances in two conditions of the Director Task, a social and a non-social condition. The social condition (or Director Condition) was a version of the classic DT by Keysar et al. (2000), with a person acting as the Director and giving instructions to the child participants. The non-social condition (or Camera Condition) was based on a variant devised by Santiesteban et al. (2015) where the Director was replaced by a camera and instructions were given in a recorded metallic voice. We hypothesized that, if multilinguals' advantage in perspective taking in a communicative setting was of social-pragmatic origin, they would perform better than monolinguals in the Director Condition, but not in the Camera Condition. On the contrary, if multilinguals' superiority were underpinned by enhanced EF, that is inhibitory control, then multilinguals would outperform monolinguals in both conditions, but would perform comparably in the two versions of the task. For corroborating evidence for either a social or EF origin of the bilingual perspective taking advantage, we tested the children in

three different measures of inhibitory control and in a test of emotion understanding that makes relatively low demands on EFs, the Test of Emotion Comprehension (TEC; Pons et al., 2004). Testing children on three instead of one inhibitory control task allowed us to extract an inhibitory control measure that is minimally affected by individual task demands. We anticipated that multilinguals would show superiority both in inhibitory control measures and in the TEC, and that both measures correlate with performance in the DT. Importantly, if the bilingual advantage was due to any of the two abilities, then differences between monolingual and bilingual children should disappear when controlling for these variables.

4.2 Method

4.2.1 Participants

Eighty-seven 4.5- to 7- year-old children were recruited through two Primary schools (n = 34), located in Abingdon (Oxfordshire) and High Ercall (Shropshire), and through social media of parent groups in Birmingham (UK; n = 53). Four children were excluded in the analyses because they could speak only English but they were exposed to other languages (n =3) or did not meet the age criteria (n =1, 93-month-old). Therefore, the final sample consisted of 82 children (37 females). Forty children (M = 69.9 months, range = 54-85 months; 19 female) were monolinguals, forty-two children (M = 72.3 months, range = 54-83 months; 18 female) were multilingual (32 bilinguals and 10 trilinguals).

Information on family language background, parents' education, parents' employment and annual family income was collected through a questionnaire completed by parents (see Tables 4.1, 4.2, 4.3 and 4.4 in Appendix). SES index was calculated as described in Chapter 2. Receptive vocabulary and non-verbal reasoning abilities were measured through the British Picture Vocabulary Scale 3 (BPVS; Dunn et al., 1997) and the Coloured Progressive Matrices

(Raven's; Raven et al, 1998) respectively.

Groups were matched in terms of age, U = 59, N = 82, Z = -1.431, p =.153, SES, U = 786, N = 82, Z = -.502, p =.616, receptive vocabulary, t(80) = .610, p=.544, and non-verbal reasoning abilities, U = 666.5, N = 82, Z = -1.612, p =.107.

4.2.2 Design and Procedures

Participants were tested in two sessions of approximately 40 minutes. In the first session children were presented with one of the two conditions (Director versus Camera) of the Director Task, followed by the Pictures Task, the Bear/Duck Task, the Blue Dog/Red Dog Task and the British Picture Vocabulary Scale-III. In the second session, the other condition of the Director Task was administered, followed by the Raven's Coloured Progressive Matrices and the Test of Emotion Comprehension.

4.2.3 Measures

Background Information Questionnaire

Parents filled in the same background information questionnaire as in Study 1 (see Chapter 2). In case of bilingual and trilingual participants, parents also completed the section regarding their child's second (and third) language acquisition history, daily use and level of proficiency. As for daily use of second and third language, parents were asked to mark on a 74 mm visual analogue scale (similar to the one used by Luk and Bialystok, 2013) the proportion of daily use for the other language(s) to English in each of the four abilities (speaking, listening, reading and writing) and in different contexts (at home and at school). The two ends of the scale corresponded to 0, i.e. "No-English" use, on the left, and to 100, i.e. "All-English" use, on the

right. The distance between 0 and the point marked by parents was measured and transformed into a percentage. As for level of proficiency in the second/third language, a similar scale was used. The left end of the scale corresponded to "non-native like", while the right end to "native-like". Likewise for language use, parents rated their child proficiency in the second (and third) language in all 4 abilities (speaking, listening, reading and writing). Responses were measured and converted into percentages.

Coloured Progressive Matrices (Raven et al., 1998) See Chapter 2

The British Pictures Vocabulary Scale III (BPVS; Dunn et al., 1997) See Chapter 2

Pictures Task (Burns et al., 2012)

This task is a Simon task and measures response inhibition. Stimuli consisted of a picture of a monkey and a picture of a cat, appearing one at a time either on the left side or on the right side of a computer screen. Participants listened to recorded instructions and were told to press the monkey button when they saw the monkey and the cat button when they saw the cat. Participants were also told that sometimes the target stimulus could appear on one side of the screen and sometimes on the other. Responses were recorded using a button box with a right button showing a picture of the monkey and a left button showing a picture of the cat. The experimenter recommended to use the right hand for the right button and the left hand for the left button and encouraged children to place their hands on the buttons or close to them so that they could press the buttons as fast as possible when either the cat or the monkey appeared. Half of the trials were congruent, i.e. the stimulus appeared on the same side as the position of the button (a monkey presented on the right or a cat presented on the left), and the other half were

incongruent, i.e. the location of the stimulus and the position of the button did not match (a monkey presented on the left or a cat presented on the right). Participants completed a total of 20 trials preceded by four practice trials. Congruent and incongruent trials were presented in a pseudo-randomised order. Stimuli were presented on a Dell Latitude 5580 laptop via E-prime (E-Studio 2.0).

Bear-Duck Task (Milward et al., 2014)

This task is a Go-Nogo task adapted from Milward et al (2014). Before starting the experimental trials, children were shown the visual stimuli (the door, the bear and the duck) printed on an A4 sheet. They were told that they would see a door and that, when the door opened, either a bear or a duck would appear. They were instructed to press a green button whenever they saw the bear but not to press the button if they saw the duck. Children were encouraged to keep one hand on the button and to press the button as fast as they could when they saw the bear. After a fixation cross appeared in the middle of the screen for 1000 ms, an image of the closed door was shown for 3000 ms, followed by a "boing" sound accompanied by the image of the open door for 1000 ms. Afterwards, the image of either the bear or the duck within the door frame was shown for 1000 ms. There were 3 blocks of 12 trials, half of the trials presented the bear and half presented the duck in randomised order. Responses were recorded using a button box and stimuli were presented on a Dell Latitude 5580 laptop via E-prime (E-Studio 2.0).

Blue dog / Red dog (Beveridge et al., 2002)

This is a Stroop task. Stimuli consisted of a picture of a blue dog and a picture of a red dog. The task was introduced to children through a PowerPoint presentation displayed on a Dell

Latitude 5580 laptop. In the first slide the picture of the red dog was presented with a speech bubble which read “My name is Blue”. The experimenter read the text aloud in a “dog-like” voice and explained the task: “This dog is called Blue. When you see him, you need to say his name”. Then, the child was invited to say the dog’s name. In the second slide, the blue dog was introduced in the same way. There were four practice trials, followed by 24 experimental trials. During the practice trials, slides were manually advanced by the experimenter and, in case of mistakes, participants were reminded of the rule. In the experimental trials, slides advanced automatically after 2400 mms. The target stimulus would appear for 2000 mms and a blank screen was shown for 400 mms between the appearance of the stimuli. Half of the trials presented the blue dog and the other half the red dog. The order of presentation of the stimuli - red dog (r), blue dog (b), b, r, b, r, r, b, b, r, b, r, r, b, r, b, r, b, b, r, r, b, r, b, b, r, r, b, r, b, b, r, r, b - was similar to the one used in Gerstadt et al. (1994), and followed the criteria of avoiding both more than two repetition of the same response and more than two alternations between responses. There were four red dog repetitions and 4 blue dog repetitions, ten switches from “Red” to “Blue” and nine switches from “Blue” to “Red”. Responses were video recorded and transcribed.

Communication tasks

Two modified versions of the Director Task were administered: a social condition (Director Condition) and a non-social condition (Camera Condition). The order of administration of the two conditions were counterbalanced across the two groups. Half of each group were presented the Director condition first, that is during the first testing session, and the Camera Condition afterwards, that is during the second testing session. For the other half of each group, the order of presentation of the two conditions was reversed. The same 4x4 boxes grid from

Study 1 was used with four blocked boxes on the Director/Camera side. Eight objects were placed on the grid, three in privileged ground (i.e. visible only on the participant's side of the grid) and five in common ground (i.e. visible on both sides of the grid). Two practice trials and twelve experimental trials in four different displays were presented for each condition. A set of three instructions (one of which critical) was presented for each display and the grid was rotated 90° anti-clockwise after each set of instructions. Five identical boxes in different colours (red, blue, black, white, golden) were placed in front of the grid on the participant's side. Instructions required children to remove one of the items from the grid and put it into a specifically coloured box. After each instruction was performed, the experimenter said "Ok, let's do another one" and the selected item was put back to its original position on the grid. One point was rewarded for each correct selection in critical trials, for a maximum score of 4 points. Scores were calculated on first responses.

Director condition. This was the social condition of the task. Instructions were given by a confederate and contained the verb of perception "to see", e.g. "I can <u>see</u> a big cup. Put the big cup into the blue box". The experimenter would introduce the task to the child in a similar way as it was presented in Study 1, showing them the grid on the Director's side first. In the two practice trials, participants were made to act as Director and the experimenter suggested two instructions for the child to give to the confederate. On the first instruction the confederate would intentionally make an egocentric mistake and select a distractor object (i.e. an object in privileged ground that would meet the description of the instruction). At this point the experimenter, who sat next to the child, would ask them, in tone of confused surprise, whether the confederate had selected the right object. If the confederate's mistake was not acknowledged by the child, then the experimenter would explain why the selection was incorrect. Then, the experimenter would tell the confederate: "We could not see that [object] from our side! Let's try

again! This time remember that from this side we cannot see everything that you can see". A second critical instruction was presented and this time the confederate performed it correctly. The child was then shown the grid from the other side and made aware that the correct object had been selected despite the presence of a referential alternative (the same object in a slightly different size) in one of the blocked boxes. After the two practice trials, participants and confederate swapped positions. The confederate turned his back to the grid during the setting up of the four different experimental displays and participants were made believe that the confederate was unaware of what objects would be placed on the grid.

Camera condition. This task was modelled after the non-social version of the DT designed by Santiesteban et al. (2015), in which the human figure of the Director was replaced by a camera. We used an iPhone 6 plus mounted on a tripod as camera. Instructions were recorded in a metallic voice and played by a Dell Latitude 5580 laptop. Instructions were phrased avoiding verbs of perception, i.e. "There is a small pig in the picture. Put the small pig in the red box". Children were first shown a practice setup on the privileged side of the grid, then they were told that they had to take photos of the display using a remote shutter. Experimenter said: "You need to take pictures of the grid using this remote control but you also need to remember that not all the objects which are on the grid come in the picture". The child was then invited to click the remote shutter and take a photo. Afterwards, they were asked to go, check the photo and say what came in the picture. Lastly, participants were told that there was something in the picture that should not be in the picture and that they had to listen carefully to the recorded instruction, take away the object, put it in the right colour box and take another photo by clicking the remote shutter again. There were 2 practice trials and after each of them children were invited to go to the phone and check the picture. In case participants had removed the distractor instead of the target, the experimenter, looking at the phone, would say: "Oh, no! There's still

the [target object] in the picture. You took away a [distractor object] but that one was not in the picture! Remember that not all the objects come in the picture". If participants had performed the instruction correctly, the experimenter, by checking the photo, would give positive feedback and would point out that they did not remove the distractor because it was not in the picture. After the practice, participants were told that they could no longer go and check the picture every time they took a photo but that they had to stay on the privileged side of the grid all the time.

Test of Emotion Comprehension (Pons et al., 2004)

This task measures children's ability of understanding emotion of others. We assessed children in seven components of emotion comprehension: recognition, external cause, desire, belief, reminder, hiding and mixed. The first five trials (recognition) presented children with four cartoon faces expressing one of the following emotions: happy, sad, angry, just alright or scared. Participants were asked to point to the picture depicting the emotion that was mentioned. In the remaining trials, a cartoon scenario was presented along with a short story which explained the situation depicted. After listening to the story, children were asked to select a facial expression out of four choices and attribute it to the target character of the story, whose face was left blank in the picture. Five (external cause) trials assessed children's understanding that emotions can be triggered by external events and required children to attribute an emotion to the main character on the basis of different events happening to them (e.g. a younger sibling disturbing their drawing, receiving a present, etc.); two (desire) trials assessed children's understanding that the same situation can prompt different emotions in people with different desires and required to attribute emotions to two characters with opposite likes and dislikes who found a same food/drink in a box; one (belief) trial assessed children's understanding that emotional states can depend on one's beliefs and required to take the perspective of a character who held a false

belief and indicate how they were feeling; two (reminder) trials assessed children's understanding that memories can prompt emotional reactions and required to indicate the emotion triggered in a character by different reminders; one (hiding) trial assessed children's understanding that people may hide their emotions and required to indicate the emotion of a character who showed a facial expression not appropriate to the situation (a character with a smiley face while they were being teased); one (mixed) trial assessed children's understanding that a same situation can trigger contrasting emotions simultaneously and required to indicate the emotional state of a character facing an ambivalent situation. The task was administered through a PowerPoint presentation displayed on a Dell Latitude 5580 touchscreen laptop. The script of the task was recorded in a neutral female voice and embedded in the presentation, which was manually advanced by the experimenter. To support participants' attention, children were encouraged to touch interactive buttons on the screen on trials where memory check questions were asked. A total of 17 trials were administered: 5 assessing recognition, 5 external cause, 2 desire (2 questions each), 1 belief (2 questions), 2 reminder, 1 hiding, 1 mixed. For each correct answer 1 point was rewarded, with a maximum score of 20 points.

4.3 Results

4.3.1 Inhibition tasks

Before running the analyses on the Inhibition tasks, the number of correct trials needed in each task for a participant to score statistically above chance was calculated. All tasks required responses between two alternatives. Therefore, performance was assessed against a 50% chance baseline. After computing the binomial probability on number of trials, we included in the analyses that children had to reach at least 75% accuracy in the Pictures Task (as 15/20 has a one-tailed probability of 0.022 by binomial test), at least 67% accuracy in the Bear/Duck Task

(as 24/36 has a one-tailed probability of 0.033 by binomial test) and at least 71% in the Blue Dog Red Dog Task (as 17/24 has a one-tailed probability of 0.032 by binomial test). Therefore, the final sample for the Pictures task consisted of 65 children (30 monolinguals and 35 multilinguals), for the Bear/Duck task the sample consisted of 76 children (37 monolinguals and 39 multilinguals) and for the Blue Dog Red Dog Task the sample consisted of 78 children (36 monolinguals and 42 multilinguals). For the RT analysis, we removed RTs faster than 200 ms (anticipatory responses) and slower than 2.5 SD above the mean of each participant. RT data removed from the analyses of the Pictures Task amounted to 7.6% of trials. RTs of incorrect responses were not considered in the analyses. As for the Bear/Duck task, we noticed that most children did not keep their hands on the button and did not follow the instruction to press the button as fast as possible, therefore, RTs were not included in the analyses. Furthermore, RTs were not recorded for the Blue Dog Red Dog Task. Table 4.5 in Appendix shows mean accuracy (and RTs) by group in each task.

Following DeGutis et al. (2013) and Milward et al. (2017), an inhibition index for each task and for each participant was obtained by, first regressing scores for "high inhibition trials" (i.e. incongruent trials in the Pictures task, No-go trials in the Bear/Duck task and Stimuli Switch Trials in the Blue Dog Red dog task) onto scores for "low inhibition trials" (i.e. congruent trials in the Pictures task, Go trials in the Bear/Duck task and non-switch Trials in the Blue Dog Red dog task), and then comparing actual performance scores in high inhibition trials to the ones predicted by performance in low inhibition trials, i.e. calculating standardized residuals based on the regression model. In case of the Picture Task, accuracy and RTs scores were comprised into a single performance score before calculating the inhibition index. For that, as in Milward et al. (2017), Pictures accuracy scores and RTs were transformed into z-scores, the signs for RTs were reversed so that higher scores indicated better performance, and then the two z-scores were

averaged. Finally, inhibition indices for all tasks were averaged for a composite inhibition index. There were 23 participants (13 monolinguals and 10 multilinguals) who had been removed from the analysis of one of the tasks, so their composite inhibition indices were based on the average of the other two tasks. Two participants (both monolingual) had been removed from two tasks, so their inhibition indices were based on one task only. For all inhibition indices, higher scores represent better inhibition ability. Table 4.6 in Appendix shows means and SDs of the inhibition indices of each task plus the composite inhibition score by group. Analyses showed a significantly better performance by multilinguals than monolinguals in each task **(**Pictures Task, $t(63) = -2.285$, $p = .026$; Bear/Duck Task, $U = 439.5$, $N=76$, $Z = -2.948$, $p = .003$**;** Blue dog /Red Dog, $t(51.683) = -4.140$, $p<.001$)**.** Multilinguals had also significantly higher composite inhibition scores, thus stronger inhibition abilities, than monolinguals, $t(53.197) = -3.814$, $p<.001$.

4.3.2 Test of Emotions Comprehension (TEC)

Table 4.7 in Appendix shows means and SDs of correct responses for the TEC. A t-test revealed no difference between the groups, $t(80) = -1.061$, $p=.292$. As BPVS and Ravens were positively correlated with TEC scores ($r=.337$, $n=82$, $p=.002$ and $r=.482$, $n=82$, $p<.001$, respectively), an ANCOVA was performed with the two variables as covariates. However, there still was no significant difference between the two groups, $F(1,78) = .287$, $p=.593$.

4.3.3 Communication Tasks

Table 4.8 in Appendix shows mean correct responses for the communication tasks (see figure 4.1). Responses were analyzed with the means of a two-way ANOVA, with Condition as

a within-subject factor (Director vs Camera) and Group as a between-subject factor (Monolinguals vs Multilinguals). There was a main effect of Condition, with higher scores for the Director than the Camera condition, $F(1,80) = 6.4$, $p = .014$, $\eta p^2 = .074$, and a main effect of Group, with higher scores for Multilinguals than Monolinguals, $F(1,80) = 33.9$, $p < .001$, $\eta p^2 = .298$, but no interaction between Condition and Group, $F(1,80) = 1.4$, $p = .344$[1]. As BPVS and Ravens scores were positively correlated with the Director Condition scores ($r = .238$, $n = 82$, $p = .031$ and $r = .336$, $n = 82$, $p = .002$, respectively) and Ravens scores were positively correlated with the Camera Condition scores ($r = .381$, $n = 82$, $p < .001$), centered BPVS and Ravens scores were entered as co-variates into an ANCOVA. We entered centered scores as covariates instead of the raw scores so as to estimate the main effect of the within-participant factor Condition as in the 2x2 ANOVA (see Delaney & Maxwell, 1981). After controlling for these variables, there was still a main effect of Condition, $F(1,78) = 6.2$, $p = .015$, $\eta p^2 = .074$, and of Group, $F(1,78) = 33.4$, $p < .001$, $\eta p^2 = .300$, and no interaction between Condition and Group, $F(1,78) = .9$, $p = .344$.[1] The effect of BPVS was not significant, $F(1,78) = 2.6$, $p = .109$, but the effect of Ravens was significant, $F(1,78) = 5.7$, $p = .020$, $\eta p^2 = .068$. The interactions between Condition and BPVS, $F(1,78) = .1$, $p = .763$, and between Condition and Ravens, $F(1,78) = .7$, $p = .420$, were not significant.

Furthermore, we investigated whether inhibition skills and emotion comprehension skills

[1] In order to check whether the presentation order of the director and camera conditions might have made a difference to the results, we added the between-participant factor Presentation Order (Director first vs Camera first) into the ANOVA. There was again no effect of Condition, $F(1,76) = 1.3$ $p = .251$, but a significant effect of Group (Multilinguals > Monolinguals), $F(1,76) = 36.7$, $p < .001$, $\eta p^2 = .326$. In addition, the effect of Presentation Order was moderately significant, $F(1,76) = 1.9$, $p = .041$, $\eta p^2 = .054$. There was a significant interaction between Condition and Presentation Order, $F(1,76) = 32.3$, $p < .001$, $\eta p^2 = .298$. Performance in the Director condition was not affected by presentation order, $F(1,78) = 2.9$, $p = .093$, but performance in the Camera condition was better when the Camera condition was presented second instead of first, $F(1,79) = 15.1$, $p < .001$, $\eta p^2 = .161$. Importantly, there was no interaction between Condition and Group $F(1,76) = 1.8$, $p = .183$, between Condition, Group and Presentation Order, $F(1,76) = 1.9$, $p = .771$, or between Group and Presentation Order, $F(1,78) = 1.9$, $p = .176$. Thus, group differences were not affected by the order of the two conditions.

might be related to the performance in the Communication tasks. There was a significant positive association between the Composite Inhibition Index and the Camera Condition scores (r=.220, N=82, p=.047) and a trend for a positive association between the Composite Inhibition Index and the Director Condition scores, r=.206, N=82, p=.064. Scores in the Test of Emotions Comprehension task were positively correlated with both the Camera (r=.280, N=82, p=.011) and the Director Condition scores (r=.318, N=82, p=.004).

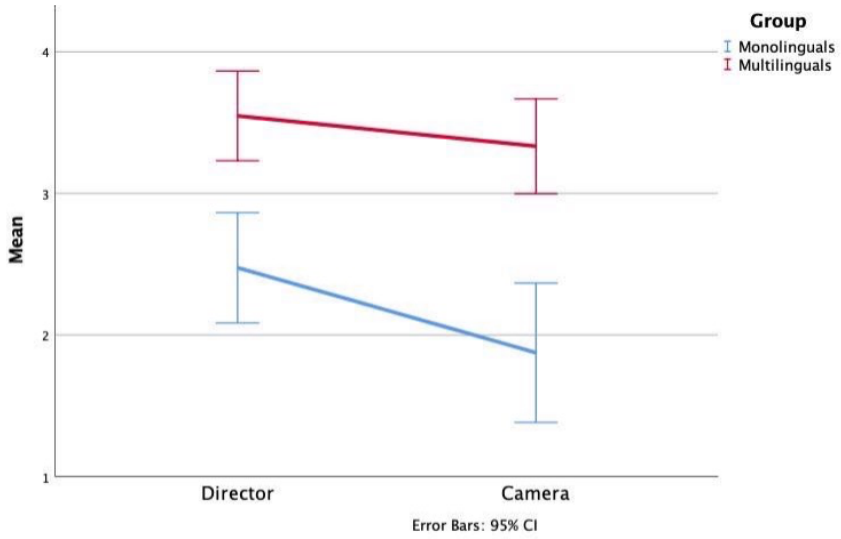


Figure 4.1. Communication Tasks - Mean of Director Condition and Mean of Camera Condition by Group

In order to investigate in how far inhibition and emotion comprehension skills can explain performance differences in conditions and groups in the Communication tasks, we centered scores of these variables and added them as co-variates into two separate ANCOVAs. After accounting for inhibition through the centered Composite Inhibition Index (in addition to BPVS and Ravens), there was still a main effect of Condition, $F(1,77) = 6.2$, $p=.015$, $\eta p^2 = .074$, and of Group, $F(1,77) = 27.5$, $p < .001$, $\eta p^2 = .263$, and no interaction between Condition and Group, $F(1,77) = .9$, $p=.358$. As there was no effect of inhibition, $F(1,77)= .129$, $p=.721$, multilinguals' superior performance in both conditions cannot be explained by their enhanced

inhibition skills. The interaction between Condition and inhibition index was also not significant, F(1,77)= .0, p=.911. After accounting for emotion comprehension (TEC), there was again a main effect of Condition, F(1,77) = 6.2, p=.015, ηp^2 = .074, and of Group, F(1,77) = 32.8, p <.001, ηp^2 = .299, and no interaction between Condition and Group, F(1,77) = .9, p=.337. There was no effect of TEC, F(1,77)= 2.4, p=.125, or interaction between Condition and TEC, F(1,77)= .1, p=.735.

4.4 Discussion

The present study aimed to explore two main accounts for a young multilingual perspective taking advantage in referential communication, i.e. the socio-pragmatic and the EF account. For this purpose, we administered two versions of the Director task, a social and a non-social version, along with measures of inhibitory control and a non-communicative perspective taking task with low EFs demands, that is the TEC. Our study had four important findings. First, multilingual children outperformed monolingual children in both the traditional Director condition and the Camera condition of the communication experiment. Second, all children, both monolingual and multilingual, achieved overall higher scores in the social condition (Director condition) of the communicative task than they did in the non-social variant (Camera condition). Third, multilinguals demonstrated superior inhibitory control in the inhibition tasks, but no difference was recorded between multilinguals' and monolinguals' performances in the TEC. Fourth, although inhibitory control and emotion understanding were positively related with children's performance in the communication tasks, the analysis of covariance showed that neither inhibition nor emotion comprehension could account for multilinguals' superior performance in the task.

The enhanced performance of multilingual children in the communication task are in line

with Fan et al.'s (2015) findings with the Director task. Together they suggest a multilingual advantage in interpreting referential instructions from another person's viewpoint. The finding that this advantage also extends to the Camera condition shows that this advantage is not limited to social interactions, but it extends to non-social contexts, too.

Children's enhanced performance in the Director condition compared to the Camera condition suggests that taking the perspective of another person in a conversation is easier for children than just representing a display from a different angle, that is without the social component of the communicative exchange. Interestingly, children who were administered the social condition first were also overall better in the Camera version afterwards. This might indicate that previous experience of receiving referential instructions from a person has led children to humanize the camera in the non-social condition and this might have made the Camera condition easier. Conversely, performance in the director Condition was not affected by presentation order, indicating that children who were presented with the Camera condition first did not transfer their approach to this task when faced with the Director condition, nor did they gain any advantage from this non-social experience when performing the Director condition afterwards.

The finding that multilingual children showed superior inhibition abilities as compared to monolinguals is in accordance with a substantial body of literature (Barac et al., 2014; Bialystok & Martin, 2004; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008; but Duñabeitia et al., 2014; Morton & Harper, 2007). As multilinguals outperformed monolinguals in all three different inhibition measures, this result is not likely to be task-dependent, and, therefore, further evidence that multilingualism leads to EF enhancement in children.

The finding that performance in the Camera condition was significantly related to

Inhibition scores plus the trend towards significance for the Director Condition, confirms previous conclusions that inhibition plays a role in the interpretation of referential instructions (Nilsen & Graham, 2009). The analysis also revealed that both Camera and Director condition scores were related with TEC scores, indicating that social understanding might play a role in interpreting referential instructions both in social and non-social context. However, despite these relationships, neither inhibition abilities nor emotion comprehension abilities explained the multilingual advantage in the communication tasks and thus inhibitory control and social understanding might not be critical skills that enhance multilingual children's perspective-taking skills in referential communication. The result that inhibition ability cannot explain the multilingual advantage in the communication tasks, is in line with the suggestion that multilinguals' perspective taking skills in a communicate setting are not underpinned by enhanced EFs (Fan et al., 2015; Liberman et al., 2017). However, we did not find that the multilingual advantage in the communication tasks can be explained by their performance in the TEC either, suggesting that multilingual superiority in referential perspective taking is not due to their enhanced social skills either. In fact, contrary to what others found (Berguno & Bowler, 2004; Farhadian et al., 2010; Goetz, 2003; Kovács, 2009; Nguyen & Astington, 2014), multilinguals and monolinguals in our study did not differ in the ability to reason about others' emotional, thus mental states. However, it is to be noted that previous studies which detected a bilingual advantage in ToM reasoning were conducted on younger children (3 to 4/5-year-old children) than those in our cohort who were aged 4.5 to 7, as ToM False Beliefs tasks are usually solved by the age of five. Therefore, one explanation for our results in the TEC is that, although bilinguals might develop the capacity to reason about others' mental states earlier than monolinguals, the gap between monolinguals and bilinguals might disappear at the age of 5 to 7. Another possibility is that bilinguals' earlier success in ToM False Beliefs tasks might, in fact,

be due to enhanced EFs instead of enhanced social skills, while emotion comprehension requires EFs minimally and thus multilinguals and monolinguals do not differ in terms of it (note that inhibition scores and TEC scores did not correlate).

As our results do not support either the socio-pragmatic or the inhibition account of bilingual superiority in referential perspective taking, a third factor needs to be considered. Such a factor is metalinguistic awareness. Metalinguistic awareness, defined as the ability to reflect upon linguistic forms disregarding their meaning (Ramirez et al., 2014) has been found to be strongly correlated with performance in ToM tasks (Perner et al., 2002; Perner & Doherty, 1998) and is enhanced in bilingual children (see review in Barac et al., 2014). Bilinguals' superiority in perspective taking might be underpinned by an earlier understanding that the link between the meaning of words and their sound-form is arbitrary (Goetz, 2003). In a study with monolingual children, Doherty and Perner (1998) found that children who are better able to use synonyms also show a higher pass rate in False Beliefs tasks. This has been interpreted as the result of an emerging understanding that the same item (in case of object naming) or the same situation (in case of False Beliefs tasks) can have different representations (Doherty & Perner, 1998; Perner et al., 2002). More recently, Doherty and Perner (2020) defined this understanding of perspectives as the ability to create coreferential mental files, i.e. the ability to link mental files which had been previously distinctly created for the same referent or situation. Bilingual children, being familiar with the fact that the same object has different sound-form representations in different languages, might understand earlier that people represent the same reality in different ways (Goetz, 2003), or, put in Doherty and Perner's (2020) recent terminology, bilinguals might precociously acquire the ability of linking co-referential mental files. In support of this account, a recent longitudinal study on preschoolers by Diaz and Farrar (2018b) found that metalinguistic abilities at a first testing point predicted bilingual performance

in False Beliefs tasks at the second testing point, while language ability and inhibitory control were the predictive factors for monolingual children's ToM abilities.

Returning to the present results, in both Camera and Director conditions, children were not only required to inhibit their own view of the display, but they also had to consider that the target object could be described differently depending on the view (front or back of the grid). In other words, a same ball that could be described as "medium-sized" from the children's vantage point (as they could also see a smaller and a bigger one on the grid) could be described as "small" if viewed for the Camera/Director's angle (as only a bigger one was visible in the Camera/Director's restricted view). Therefore, multilinguals might have performed better than monolinguals in both conditions of the communication task thanks to their better "understanding of perspectives", i.e. that a same referent can be described and represented in different ways. Future studies should explore this account.

To conclude, we have provided further evidence of a bilingual advantage in referential perspective taking. Our findings indicate that neither inhibitory control nor social skills are crucial for this advantage. Therefore, we speculated that bilinguals' greater experience and understanding that one and the same referent can have multiple linguistic labels might underpin their superiority in referential perspective taking tasks. Further experimental investigations are needed to establish the role of this metalinguistic awareness in bilinguals' referential perspective taking abilities.

CHAPTER 5
GENERAL DISCUSSION

5.1 General Discussion

This thesis addressed two questions related to early second language learning. The first question was whether learning a second language in the first year of formal education could trigger non-linguistic enhancements. I focused my investigation on EFs, creative thinking and perspective-taking, as these three areas of cognition had been found to be enhanced by early bilingual experience in natural contexts. The second question concerned the underpinning of the bilingual advantage (in natural settings) with regard to perspective-taking. More specifically, I explored two main accounts which have been proposed for this advantage, that is the EF and the socio-pragmatic account. Chapters 2 and 3 presented the experiments I conducted to address the first question. Chapter 4 presented the experiments related to the second question. In this final chapter I will, first, summarize the findings regarding early L2 learning in formal settings and suggest future directions for research. Then, I will recap the results regarding the underpinning of the bilingual advantage in perspective taking. I will critically analyze them also in light of the findings presented in Chapter 2 and pinpoint the questions that remain open for future work. Finally, I will outline the contribution of this thesis to the existing literature on bilingualism and discuss some methodological implications.

5.1.1 Early second language in formal settings

The first area likely to be enhanced by early second language learning at school is EFs. We focused our investigation on attentional abilities and cognitive flexibility. Three groups of monolinguals with different amount of weekly exposure to a second language performed the Attentional Network Task and the DCCS task. One group had substantial exposure to a L2 being

immersed in the new language for half of the school time (BilS), another group had only limited exposure through a weekly L2 class (WL2), and a third control group did not have any exposure to a L2 (NoL2). We administered the tasks at the beginning of the school year (i.e. during very early L2 exposure) and after 24 weeks to compare the developmental trajectories between the groups. All groups showed equivalent scores at the initial testing point, both in the ANT and in the DCCS. However, different results were recorded at TP2. In the ANT, we did not find any difference in the groups' improvement rates for any of the three attentional networks of alerting, orienting and conflict. By contrast, in the DCCS both groups of language learners recorded a superiority over the non-language learning group at TP2. Taken together, these results suggest that early L2 learning, at an initial stage, does not enhance children's attentional skills but promotes flexible thinking. Failure to find a L2 advantage in the ANT, particularly in the conflict network, might be due to the fact that at TP2 neither group of L2 learners had reached good competence in the target language or had much opportunity to actively use it. Traditionally, bilingual superiority in conflict resolution has been linked to higher levels of L2 speaking skills and to a frequent use of the second language. A better L2 proficiency along with a more substantial practice in speaking might have been needed to boost children's attentional skills. In contrast, the case of cognitive flexibility is different. Our finding in regard to the DCCS task is very remarkable, as even weekly L2 learners showed superiority in spite of their scant L2 speaking skills and practice in the use of the L2. It has to be noted that the group with more intense exposure to the second language, i.e. the group of bilingual school children, showed an additional advantage in the DCCS over the group of L2 learners who had only limited amount of exposure. This suggests that the amount of exposure increases switching ability. Moreover, weekly L2 learners' advantage over non-L2 learners was found only when we accounted for their L1 verbal ability and non-verbal reasoning skills. Nonetheless, our finding importantly

shows that introducing L2 activities during the first year of formal education is beneficial to children's mental flexibility. We speculated that children's representational skills might have been enhanced by L2 exposure, which resulted in a enhanced mental flexibility.

The other area potentially affected by early second language learning at school is perspective-taking. As described in Chapter 2, we administered a task where we asked children to move objects on a 4x4 array of boxes. Children had to interpret referential instructions from the angle of a "director" who had a limited view of the array. Again, there was no difference between the three participant groups at TP1, but at TP2 the non-L2 learning group was outscored by the two groups of L2 learners, with the latter two performing comparably. This pattern of results remained after DCCS scores were accounted for, indicating that enhancement in perspective-taking skills was not due to enhancement in cognitive flexibility. These findings are in line with the suggestion that EFs are not crucial for this task (Fan et al., 2015). The notion that enhanced EFs are not the key factors for superiority in the DT was further supported by the results of the experiments on young bilinguals which will be discussed in the next section. As for the present experiment with L2 learners, the possibility that L2 learners' superiority in the task was social in origin was left open by the results we recorded. However, the socio-pragmatic account has not been confirmed by the experiment with young bilinguals presented in Chapter 4. As for children who acquired their L2 in natural contexts, L2 learners' superiority in the DT can be speculatively explained by enhanced ability to reflect upon language, i.e. metalinguistic awareness. Realizing that familiar objects are named differently by different people who speak another language might support children's understanding of perspectives. The understanding of perspective might be involved, even if in different ways, both in the DCCS and the DT performance. It has been proposed that young children fail the standard version of the DCCS task because they lack the understanding that a same entity can be described under different

perspectives (Kloo & Perner, 2003, 2005; Perner & Lang, 2002). The same understanding of perspective is also needed to pass false beliefs tasks (Doherty & Perner 1998; 2002; 2020) and to be able to use synonyms (Doherty & Perner 1998). Despite the positive relationship between the advanced version of the DCCS and the DT, the two tasks tap into common abilities differently. The advanced DCCS, for example, also requires a constant shift between co-representations, and this might not be essential in the DT. By contrast, the DT requires mindreading abilities which are not needed in the DCCS.

The third area which we considered in regard to early second language learning at school is creative thinking. We administered a modified version of the repeated figures of the TTCT, where children were presented with a series of squares (or parallel lines) and asked to turn the squares (or the lines) into something else within their drawings. The aim of the task was to see whether children were able to generate a large number of different ideas out of the same pictorial stimulus. We scored responses under the dimensions of fluency, i.e. number of ideas produced, and flexibility, number of conceptual categories the ideas belonged to. There was no difference between the three participant groups at TP1. However, at TP2 children in bilingual education showed higher scores both in fluency and flexibility as compared to the non-L2 learning group. At TP2 the difference between weekly L2 learners and non-L2 learning children did not reach statistical significance in either dimensions, despite a numerical superiority on the part of the L2 learning group. This suggests that weekly L2 learners' exposure was not enough to boost children's creative fluency and flexibility. At TP2 weekly language learners did not significantly differ from bilingual school children, either. This raises the possibility that an increase in the amount of exposure might have resulted in benefits in this area of cognitive development, too, just as the amount of exposure modulated improvements in cognitive flexibility.

A sub-question related to creative thinking was whether the bilingual advantage in

creativity was underpinned by enhanced EFs. Interestingly, we found correlations between EFs and divergent thinking scores. In particular, creative fluency scores were negatively correlated with conflict scores in the ANT, while creative flexibility scores were positively associated with DCCS scores. These findings back up the ideas that higher selective attention skills rather hinder creative fluency (Hommel et al., 2011) and that creative flexibility might be supported by general cognitive flexibility. Our findings also suggest that the two creativity dimensions of fluency and flexibility are not entirely explained by EFs skills. In fact, when we accounted for ANT conflict scores, the difference in creative fluency between the group of children in bilingual education and the non-L2 learning group did not disappear. As for creative flexibility, when we accounted for DCCS scores, only the difference between bilingual school children and weekly L2 learners disappeared, but the difference between bilingual school children and the control group remained. Therefore, despite some commonalities, flexibility in creative production does not entirely depend on general cognitive flexibility. Cross-category shifting during creative production might be favoured by general cognitive flexibility, however, a limited exposure to the L2 might not have sufficiently broadened weekly L2 learners' associative system.

Taken together, the experiments presented in Chapter 2 and Chapter 3 have shown that starting to learn a new language in the first year of school has a positive impact on children's cognitive development. Our results identified two areas which are boosted even by a minimal exposure to a second language, i.e. general cognitive flexibility and perspective-taking. Enhancement in these two areas are very important for children's future academic and social life. Cognitive flexibility is a predicting factor of early reading comprehension abilities (Colé et al., 2014) and academic achievements in literacy (Magalhães et al., 2020; Nayfeld et al., 2013), math (Magalhães et al., 2020; Nayfeld et al., 2013) and science (Nayfeld et al., 2013).

Perspective-taking abilities in early childhood predict prosocial behaviour (Imuta et al., 2016), popularity among peers (Slaughter et al., 2015) and social competence when children leave primary school (Devine et al., 2016). For these reasons policymakers and school curriculum designer should consider lowering the age at which an L2 is learnt at school and introduce L2 activities in the first year of formal education.

As far as we know, ours is the first study that explored the cognitive advantages of receiving L2 classes in mainstream schools. This area needs to be further investigated. In particular, it remains to be defined which is the minimum amount of exposure required to gain cognitive enhancement and whether the advantages are maintained in later years of schools. Another important question which was not addressed by the present work is whether L2 learning can improve working memory. Future studies should consider also this EFs component, given that WM has been found to be enhanced in young emerging bilinguals (Blom et al., 2014). It would also be useful to know whether increasing the amount or the frequency of L2 exposure in mainstream schools could extend the advantages we have found for divergent thinking skills in children in bilingual schools.

In regard to children in bilingual education, our study found that the experience of being taught in a new language for almost half of the school time improved their development in cognitive flexibility, communicative skills and creativity abilities in their first six months of school. A longer longitudinal study with more testing points could monitor the developmental trajectories of these skills in the later years of school. It would be very interesting to find out whether and how the acquisition of better speaking proficiency or a more extensive use of the L2 would influence children's development in these areas and if the advantage would extend to attentional processes. As for the impact of bilingual education on divergent thinking skills, with our experiment we clarified some ambiguities contained in earlier research and showed that

fluent and flexible thinking during creative production is not achieved only in later grades but it is enhanced during the first year of L2 immersion. Future experimental investigations are needed to clarify the underpinning of this advantage, with particular regard to the hypothesis that it emerges because L2 learning enriches children's cross-category associative network. Future work should also consider whether enhancement in creativity might be due to the bi-/multicultural environment offered by bilingual schools. It has been suggested that culturally heterogeneous socio-political contexts have favoured the flourishing of innovators and big creative personalities in the past (Simonton, 2003). Likewise, on a micro-social level, it might be that bilingual schools are more likely to cherish cultural diversity and thus create a favourable environment to support pupils' creative thinking.

5.1.2 The early bilingual advantage in perspective taking

The second question of this thesis concerned the reasons for the perspective taking advantage in bilinguals who acquired their second language in 'natural' environments (thus not in formal education). More specifically, we aimed to explore two main explanations that have been suggested for the bilingual advantage of perspective taking, the EFs and the socio-pragmatic account. We administered two variants of the referential perspective task used in Chapter 2 to a monolingual and a bi-/multilingual group of children. In the social variant of the task (the Director condition), a person, the "director", asked children to remove objects from the display and put them in a specifically coloured box. In the non-social version (the Camera condition), the director was replaced by a camera and children were asked to take pictures of the display using a remote shutter. We argued that, if the bilingual advantage in perspective taking was due to their enhanced socio-pragmatic skills, bilinguals would outperform monolinguals in the Director Condition, but not in the Camera Condition. By contrast, if the bilingual advantage

were underpinned by enhanced EF, that is inhibitory control, then bilinguals would outperform monolinguals in both conditions, but would perform comparably in the two versions of the task. We also administered three different measures of inhibitory control and the Test of Emotion Comprehension (Pons et al., 2004) in order to substantiate our findings in support of either the EF or of the socio-pragmatic account.

All children, both monolingual and multilingual, performed overall better in the Director condition of the communication task than they did in the Camera condition. This suggests that the social context facilitated non-egocentric interpretations of referential instructions. Multilingual children outperformed monolingual children in both versions of the communication experiment. Importantly, there was no difference between bilinguals and monolinguals in the Test of Emotions Comprehension, while bilinguals outperformed monolinguals in the inhibition tasks. Although inhibitory control and emotion understanding were positively related with children's performance in the communication tasks, we did not find any supporting evidence for either the EF or the socio-pragmatic account, as neither inhibition scores nor TEC scores ultimately accounted for the multilingual advantage. Therefore, we proposed an alternative explanation drawing on Doherty and Perner's (1998; 2002; 2020) suggestion that perspective-taking abilities depend on children's acquisition of the concept of perspective, i.e. the ability of linking co-referential representations. As mentioned in the previous section, this notion is also connected to children's metalinguistic awareness and, in particular, to children's ability to use synonyms (Doherty & Perner, 1998). Therefore, it is possible that perspective-taking abilities in bilingual children are enhanced through their precocious understanding of the arbitrary nature of language. Being used to the fact that a same entity can have multiple labels, as it has different labels in different languages, bilinguals could acquire the concept of perspective earlier than monolinguals. We speculated that in the communication tasks that we administered, children had

to be able to understand that the same object can be simultaneously described, for example, as "small" or as "medium-sized" according to what other size objects are visible to the speaker. Children needed to understand, for example, that the same ball that they would describe as "medium-sized" because they could see other two balls (a smaller and a bigger one as compared to the target one) could be characterized as "small" by their interlocutor who could only see another, bigger, ball beside the target one. Future studies should explore the metalinguistic awareness account for the bilinguals' and L2 learners' advantage in conversational perspective-taking. In particular, work is needed to see whether the advantage in the director task depends on a better understanding that linguistic labels are not intrinsic features of the entities that they indicate.

5.1.3 The bilingual advantage debate

The present findings address the ongoing debate about the existence of a 'bilingual advantage'. In contrast to other studies that did not find any difference between monolingual and bilingual children in EFs measures (Duñabeitia et al., 2014; Gathercole et al., 2014; Morton & Harper, 2007), we found that monolingual children with no experience of a second language recorded lower scores in measures of cognitive flexibility as compared to their peers learning a L2 at school, and that monolingual children had inferior inhibitory control as compared to children who could speak more than one language.

The bilingualism literature often refers to 'THE bilingual advantage'. The findings in the present thesis together with findings in the literature suggest that there is not a single advantage. A recurrent finding in the experiments presented in this thesis is that early experience of a second language, both in natural and in formal contexts, enhances children's representational abilities, regardless its impact on EFs. Superior perspective taking abilities were not explained

by enhanced cognitive flexibility in the experiment with learners of L2 at school, nor were they accounted for by enhanced inhibitory control in the experiment with young bi- and multilinguals. Similarly, superior creative fluency and creative flexibility of children in bilingual schools were not dependent on either inhibitory control or cognitive flexibility. Thus, instead of a single bilingual advantage, bilingualism seems to lead to enhancements of various abilities that cannot be linked to a single improved cognitive skill.

Bilingualism is a multidimensional, complex phenomenon. Several factors, such as age and context of L2 acquisition, intensity of L2 immersion, frequency and contexts of L2 usage make the bilingual experience extremely varied, which might explain inconsistency in results (Kroll & Bialystok, 2013; Ooi et al., 2018). In contrast to the controversial outcomes of behavioral studies, neuroimaging research have shown undisputed evidence that bilingualism brings about structural and functional changes in frontal and parietal areas of the brain related to both language and executive control (for review see García-Pentón et al., 2016; Li et al., 2014). However, it is still unclear how these modifications are connected to the advantages recorded through behavioural measures. Furthermore, the different traits of the bilingual experience (e.g., modality of L2 acquisition and frequency of L2/L1 usage) have been shown to result in different brain adaptations (DeLuca et al., 2019)

Due to the replication crisis in the field, suggestions have been made of how to move forward. For instance, Backer and Bortfeld (2021) stressed the importance of approaching bilingualism with a lifespan perspective. A lifespan approach is particularly important in consideration that bilingual effects have been more consistently documented in childhood and older adulthood, while studies on young adults have mainly shown no differences between monolinguals and bilinguals in EFs tasks (Antoniou, 2019). This consideration is also relevant in evaluating our results concerning bilingual education and early L2 learning. It might be that

some differences can be detected only at particular stages of formal L2 learning. This does not imply that one should dismiss or accept in toto the idea that bilingual education and formal L2 learning influence non-linguistic aspects of children's development. In the study presented in Chapter 2 and 3 we aimed to see whether the first encounter with a second language would impact on children socio-cognitive skills. However, more work is needed to understand if and how the gains we detected remain in later stages of life.

Another crucial recommendation for better understanding the bilingual effects is to conduct more longitudinal investigations (Poarch & Krott, 2019). Making use of a longitudinal design, in the study presented in Chapter 2 and 3, we were able to detect differences in developmental trajectories since the earliest stage of L2 learning, which had not been captured by previous cross-sectional research, such as, for example Landry's (1973a) study on creativity. Longitudinal studies are also required in order to identify more precisely how the experience of bilingualism and L2 learning impact on cognitive and socio-cognitive skills. The existence of a bilingual effect does not necessarily imply enhancements in particular cognitive areas. Instead, bilinguals might solve complex cognitive problems engaging different skills and abilities compared to monolinguals, and this might be picked up in longitudinal studies. For example, through the means of a longitudinal study Diaz and Farrar (2018b) showed that young monolinguals' and bilinguals' ability to reason about false beliefs depended on different skills, namely it depended on short- term memory and inhibitory control for monolinguals but on metalinguistic awareness for bilinguals. Therefore, the question is not always whether bilinguals do something better than monolinguals but whether they do something differently (Poarch & Krott, 2019).

A third recommendation concerns the use of more unified paradigms (Poarch & Krott, 2019). There is a great variability across studies in the design and the execution of EFs

measures. Differences in the number of trials, for example, or (especially in the case of research on children) whether the task is computerized or not, might cause diverging results. We found this for the DCCS, a task widely used in research with bilingual children. The implementations of the DCCS across the studies differ in terms of stimuli, total numbers of trials, ratio between switch and non-switch trials and modality of administration. This makes it particularly difficult to compare our results on L2 learners to previous findings.

Another important proposal for future research is to move beyond testing EFs by themselves and consider other, more ecological, aspects that can be impacted by bilingualism (Poarch & Krott, 2019). In the light of the results of this work we fully endorse this recommendation. On the one hand, we found that important improvements in preschoolers' cognitive development might be triggered without an enhancement in EFs and, on the other hand, even when EFs are actually enhanced (e.g. in our study on young bi-/multilinguals), they are not necessarily the reasons for gains in other areas of cognition, such as perspective taking or creative thinking. Maybe more importantly, moving beyond EFs, we found that early L2 learning impact on areas which crucially impact on children's everyday life, that is communication and creativity.

5.2 Conclusion

The present thesis has provided evidence that early L2 learning has beneficial effects on children's socio-cognitive development. A final consideration needs to be made about how L2 learning is perceived at initial stages of education. L2 learning is often considered "nice to have" during early years of school. It is certainly not deemed essential to children's personal and social development. Nurseries and Infant schools do not always offer a L2 provision. The formative value of L2 learning, which, as we demonstrated, goes beyond some L2 acquisition, is often

underestimated. In light of our findings, more space should be dedicated to L2 learning in pre-school and school curricula. Indeed, more work is needed in the field. It is still to be clarified how L2 provision should be structured, in terms for example, of teaching approach and frequency and length of exposure, in order to reach significant cognitive changes. There is also the need for more scientifically grounded information for the public. Educators and parents should be more accurately made aware of which are the cognitive and social benefits that L2 learning can (and cannot!) bring about during early years of school, in order to enable them to make better informed choices about their children's education.

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Appendix

Table 2.1 Descriptive statistics for background measures - Participants Chapter 2 and 3

		BilS	**WL2**	**NoL2**
Age (in months; Mean and SD)		56.0 (4.1)**	57.2 (4.0)	59.5 (3.8)
Gender	Male	21	14	17
	Female	11	15	21
SES index		0.78 (0.19)	0.71 (0.21)	0.76 (0.16)
Maternal background: British[1]		96.9%	96.5%	100%
Paternal background: British[2]		93.8%	100%	100%
BPVS (Mean scores and SD)		74.1 (12.6)	70.9 (13.7)	72.6 (14.0)
Raven's (Mean scores and SD)		15.4 (3.3)	14.8 (3.7)	15.1 (3.6)

[1] Places of birth of non-British mothers were: USA (n=1) in the BilS group and Ireland (n =1) in the WL2 group.
[2] Places of birth of non-British fathers were: New Zealand (n=1) and South Africa (n=1) in the BilS group.

Table 2.1.2 Pearson correlations for Alerting, Orienting and Conflict Accuracy and baseline measures

	Alerting Acc1	Alerting Acc2	Orienting Acc1	Orienting Acc2	Conflict Acc1	Conflict Acc2	Age	SES	BPVS	Ravens
Alerting Acc1	1									
Alerting Acc2	.012	1								
Orienting Acc1	.010	-.076	1							
Orienting Acc2	.069	.135	-.108	1						
Conflict Acc1	.340**	.089	-.138	.114	1					
Conflict Acc2	.139	.044	.085	-.033	.270*	1				
Age	.099	.078	-.115	-.177	.109	.265*	1			
SES	-.279*	.046	-.074	.028	-.118	.032	-.029	1		
BPVS	.146	.226*	.069	.205	.133	.053	.037	-.106	1	
Ravens	.214	-.050	-.254*	.089	.125	-.075	.056	.062	.188	1

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 2.1.3 Pearson correlations for Alerting RT, Orienting RT, Conflict RT baseline measures

	Alerting RT1	Alerting RT2	Orienting RT1	Orienting RT2	Conflict RT1	Conflict RT2	Age	SES	BPVS	Ravens
Alerting RT1	1									
Alerting RT2	.052	1								
Orienting RT1	.039	.054	1							
Orienting RT2	.096	-.161	.086	1						
Conflict RT1	-.003	.173	.119	-.100	1					
Conflict RT2	-.139	-.035	-.092	.089	.284*	1				
Age	.109	-.041	.049	.003	-.251*	-.022	1			
SES	-.206	-.004	-.020	.126	-.232*	.057	-.029	1		
BPVS	-.053	.034	.072	-.072	.074	-.133	.037	-.106	1	
Ravens	.030	.227*	-.057	-.009	.110	.097	.056	.062	.188	1

* Correlation is significant at the 0.05 level (2-tailed)

Table 2.1.4 Pearson correlations for DCCS, DT and baseline measures

	DCCS 1	DCCS 2	DT 1	DT 2	Age	SES	BPVS	Ravens
DCCS 1	1							
DCCS_2	.238*	1						
DT_1	.258**	.155	1					
DT_2	.228*	.363**	.600**	1				
Age	.119	-.191	-.009	-.079	1			
SES	-.093	-.056	-.157	-.026	-.004	1		
BPVS	.360**	.332**	.287**	.273**	.143	.014	1	
Ravens	.229*	.186	.083	.131	.139	.078	.301**	1

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 2.2 ANT – Mean of overall correct responses and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	0.79 (0.12)	0.82 (0.08)	0.79 (0.09)
Final testing point	0.89 (0.07)	0.91 (0.07)	0.92 (0.04)

Table 2.3 ANT – Mean of overall RTs (in ms) and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	1092.2 (108.7)	1038.5 (96.5)	1066.4 (115.8)
Final testing point	927.1 (137.2)	894.9 (106.6)	932.2 (110.7)

Table 2.4 ANT – Mean correct responses and Standard Deviation for Group and Cue Type conditions at initial and final testing point

	BilS	**WL2**	**NoL2**
No Cue			
Initial	0.77 (0.14)	0.78 (0.10)	0.76 (0.13)
Final	0.86 (0.11)	0.89 (0.08)	0.90 (0.08)
Double Cue			
Initial	0.79 (0.13)	0.84 (0.09)	0.82 (0.10)
Final	0.90 (0.08)	0.91 (0.09)	0.94 (0.04)
Central Cue			
Initial	0.80 (0.12)	0.83 (0.09)	0.79 (0.10)
Final	0.89 (0.10)	0.92 (0.08)	0.91 (0.09)
Spatial Cue			
Initial	0.80 (0.13)	0.85 (0.11)	0.80 (0.13)
Final	0.90 (0.08)	0.91 (0.09)	0.94 (0.04)

Table 2.5 ANT – Mean RTs in ms and Standard Deviation for Group and Cue Type conditions at initial and final testing point

	BilS	**WL2**	**NoL2**
No Cue			
Initial	1123.1 (109.6)	1112.5 (111.6)	1110.3 (109.1)
Final	990.5 (125.2)	974.4 (116.1)	1013.1 (90.0)
Double Cue			
Initial	1080.3 (120.3)	1011.5 (112.5)	1040.6 (117.6)
Final	897.4 (152.2)	852.0 (103.9)	902.1 (121.2)
Central Cue			
Initial	1085.6 (111.3)	1034.3 (100.7)	1045.7 (115.1)
Final	919.5 (143.3)	882.9 (113.0)	921.6 (134.6)
Spatial Cue			
Initial	1078.7 (123.9)	1000.4 (115.0)	1070.4 (143.7)
Final	902.2 (153.0)	871.3 (120.6)	895.7 (127.7)

Table 2.6 ANT – Mean correct responses and Standard Deviation for Group and Flanker Type conditions at initial and final testing point

	BilS	WL2	NoL2
Neutral			
Initial	0.84 (0.10)	0.89 (0.09)	0.84 (0.08)
Final	0.90 (0.06)	0.92 (0.07)	0.92 (0.06)
Congruent			
Initial	0.84 (0.10)	0.88 (0.06)	0.84 (0.10)
Final	0.92 (0.08)	0.93 (0.08)	0.94 (0.06)
Incongruent			
Initial	0.69 (0.21)	0.70 (0.15)	0.70 (0.13)
Final	0.83 (0.12)	0.87 (0.10)	0.90 (0.10)

Table 2.7 ANT – Mean RTs in ms and Standard Deviation for Group and Flanker Type conditions at initial and final testing point

	BilS	WL2	NoL2
Neutral			
Initial	1035.3 (118.5)	984.0 (109.4)	1027.8 (114.6)
Final	875.4 (146.5)	847.0 (112.6)	890.9 (108.5)
Congruent			
Initial	1071.2 (134.8)	1007.0 (118.3)	1049.4 (125.6)
Final	903.6 (141.6)	868.8 (121.5)	911.35 (120.7)
Incongruent			
Initial	1193.6 (100.8)	1149.2 (94.3)	1133.5 (113.4)
Final	1013.2 (138.6)	974.8 (115.0)	997.9 (124.3)

Table 2.8 ANT – Alerting index mean of correct responses and Standard Deviation at initial and final testing point

	BilS	WL2	NoL2
Initial testing point	-0.02 (0.10)	-0.07 (0.09)	-0.06 (0.10)
Final testing point	-0.04 (0.09)	-0.02 (0.06)	-0.04 (0.09)

Table 2.9 ANT – Alerting index mean RTs (in ms) and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	42.0 (52.7)	101.0 (73.6)	69.7 (63.8)
Final testing point	93.1 (67.1)	122.4 (65.1)	111.0 (74.3)

Table 2.10 ANT – Orienting index mean of correct responses and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	0.00 (0.08)	-0.02 (0.09)	-0.01(0.12)
Final testing point	0.00 (0.10)	0.01 (0.09)	-0.03 (0.09)

Table 2.11 ANT – Orienting index mean RTs (in ms) and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	6.9 (72.0)	34.0 (85.2)	-24.6 (88.3)
Final testing point	17.4 (69.3)	11.8 (44.0)	26.0 (77.6)

Table 2.12 ANT – Conflict index mean of correct responses and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	-.14 (.18)	-.18 (.15)	-.14 (.11)
Final testing point	-.09 (.12)	-.07 (.07)	-.04 (.07)

Table 2.13 ANT – Conflict index mean RTs (in ms) and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial testing point	122.3 (104.4)	142.0 (100.8)	84.2 (79.7)
Final testing point	109.4 (81.1)	106.1 (100.3)	86.6 (76.2)

Table 2.14 DCCS – Mean of correct responses and Standard Deviation at initial and final testing point

	BilS	**WL2**	**NoL2**
Initial	18.4 (2.5)	18.7 (1.9)	18.8 (2.7)
Final	23.21 (1.4)	21.6 (2.5)	20.4 (2.6)

Table 2.15 Director Task – Mean of correct first responses and Standard Deviation at initial testing point

	BilS	**WL2**	**NoL2**
Initial	2.2 (1.3)	1.7 (1.5)	2.1 (1.6)
Final	3.4 (1.0)	3.2 (1.1)	2.2 (1.6)

Table 3.1 Means of creative Fluency, creative Flexibility, DCCS and Conflict composite scores (SDs) at initial (TP1) and final time points (TP2)

	N	**BilS**	**N**	**WL2**	**N**	**NoL2**
Fluency	32		29		38	
TP1		6.3 (3.4)		6.7 (2.8)		6.8 (3.2)
TP2		9.9 (3.4)		8.2 (3.4)		7.8 (4.1)
Flexibility						
TP1		4.2 (2.0)		4.2 (1.8)		3.9 (1.4)
TP2		7.2 (2.7)		5.5 (2.4)		4.5 (2.7)
DCCS						
TP1		18.4 (2.5)		18.7 (1.9)		18.8 (2.7)
TP2		23.2 (1.4)		21.6 (2.5)		20.4 (2.6)
Conflict composite	26		24		26	
TP1		.04 (.84)		.25 (.64)		-.12 (.49)
TP2		.04 (.75)		-.07 (.72)		-.26 (.55)

Table 3.1.2 Pearson correlations for creative fluency, creative flexibility and baseline measures scores

	Fluency TP1	Fluency TP2	Flexibility TP1	Flexibility TP2	Age	BPVS	Ravens	SES
Age	.034	-.098	.081	-.188	1			
BPVS	.108	.170	.245*	.113	.143	1		
Ravens	.071	.082	.148	.197	.139	.301**	1	
SES	.076	.248*	.082	.293**	-.004	.014	.078	1

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

Table 4.1 Descriptive statistics for baseline measures – Participants Chapter 4

		Monolinguals	**Multilinguals**
Age (in months; Mean and SD)		69.9 (7.7)	72.3 (7.6)
Gender	Male	21	24
	Female	19	18
SES index		.80 (.15)	0.82 (0.2)
BPVS (Mean scores and SD)		87.3 (16.0)	85.1 (17.4)
Raven's (Mean scores and SD)		21.6 (6.1)	23.8 (6.3)

Table 4.2 Languages spoken by children in the multilingual group

L1	Arabic (N=1); English (N=23); French (N=2); German (N=1); Greek (N=1); Italian (N= Mandarin (N=1); Polish (N=1); Portuguese (N=1); Punjabi (N=1); Russian (N=1); Spanish (N=5); Urdu (N=2)
L2	Catalan (N=2); Mandarin (N=2); English (N=13); Finnish (N=1); French (N=7); Germa (N=4); Italian (N=5); Polish (N=1); Portuguese (N=1); Punjabi (N=1); Sinhalese (N=1); Spanish (N=4)
L3	English (N=6); French (N=3); German (N=1); Russian (N=1); Spanish (N=1)

Table 4.3 Multilingual group – Descriptive statistics for L2 acquisition and L2 usage

Birth bilinguals	69%
Born in UK	62%
Age (in months) of arrival in UK of those who were not born in UK - Mean and Standard deviation	28.6 (22.1)
Daily exposed to other language(s) other than English	95%
Starting age (in months) of learning the L2 at home for those who were not birth bilinguals - Mean and Standard deviation	11.1 (18.0)
Starting age (in months) of learning the L2 at school for those who were not birth bilinguals - Mean and Standard deviation	40.2 (16.1)
Starting age (in months) of using the L2 actively - Mean and Standard deviation	34.1 (16.0)
Daily use of English at home – Mean and Standard Deviation	.42 (.26)
Daily use of English at school – Mean and Standard Deviation	.79 (.24)

Table 4.4 Multilingual group – Descriptive statistics for L2 proficiency

Language	Ability	N	Mean and Standard Deviation
L1	Speaking	42	.96 (.09)
	Listening	42	.99 (.04)
	Reading	39	.77 (.33)
	Writing	39	.75 (.34)
L2	Speaking	42	.73 (.24)
	Listening	42	.84 (.19)
	Reading	39	.63 (.36)
	Writing	38	.54 (.39)
L3	Speaking	11	.66 (.32)
	Listening	12	.69 (.37)
	Reading	11	.64 (.38)
	Writing	11	.61 (.42)

Table 4.5 Inhibition Tasks - Means and SDs of accuracy scores and RTs in each task

	Group	**n**	**Correct responses (proportions)**		**RTs (ms)**	
Pictures Task			Congruent	Incongruent	Congruent	Incongruent
	Monolinguals	30	0.97 (0.05)	0.77 (0.12)	911.5 (162.1)	1076.5 (212.0)
	Multilinguals	35	0.91 (0.10)	0.78 (0.14)	852.8 (118.9)	955.3 (137.3
Bear/Duck Task			Go	No-go	-	
	Monolinguals	37	0.81 (0.15)	0.96 (0.06)	-	
	Multilinguals	39	0.86 (0.15)	0.98 (0.04)	-	
Blue Dog Red Dog			Non-switch	Switch	-	
	Monolinguals	36	0.79 (0.19)	0.84 (0.12)	-	-
	Multilinguals	42	0.86 (0.14)	0.94 (0.06)	-	-

Table 4.6 Means and SDs (in parentheses) of the inhibition indices for all inhibition tasks plus the composite inhibition index by group.

	Monolinguals	Multilinguals
Pictures Inhibition index	-.29 (1.01)	.25 (0.92) *
Bear/Duck Inhibition index	-.26 (1.12)	.25 (0.79) **
Blue Dog Red Dog Inhibition index	-.47 (1.14)	.40 (0.61) ***
Composite Inhibition index	-.32 (0.93)	.29 (0.41) ***

Note. Inhibition indices for individual tasks are based on a subset of participants (see text), while the composite inhibition index is based on all participants. * difference is significant at the level of p<.05; ** difference is significant at the level of p<.01; *** difference is significant at the level of p<.001

Table 4.7 Means and SDs of correct responses in the Test of Emotions Comprehension

Group	n	TEC
Monolinguals	40	16.5 (1.7)
Multilinguals	42	16.9 (2.0)

Table 4.8 Means and SDs of correct responses for both Communication Tasks (Director Condition and Camera Condition) and for each participant group

Group	n	Director Condition	Camera Condition
Monolinguals	40	2.48 (1.2)	1.88 (1.5)
Multilinguals	42	3.55 (1.0)	3.33 (1.1)