Cognitive benefits of early bilingualism

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ABSTRACT: Numerous studies have addressed the cognitive advantages of bilingualism, i.e., there has been research on a greater cognitive potential in bilingual people, with a different development than the neurotypical one, which entails different benefits. This paper presents a bibliographic review of articles published in the last five years where it is analyzed how bilingualism at early ages positively influences the cognitive development of children and the development of executive functions. For this analysis different criteria were considered to discriminate among the many findings to ensure the validity and reliability of the study. This review aims not only to synthesize recent findings, but also to suggest pedagogical implications to foster more inclusive and effective educational environments, promoting early cognitive development from a neuroplasticity-based perspective.
Keywords: early bilingualism, bilinguals' performance, children, children's cognitive development, executive functions

Beneficios cognitivos del bilingüismo en edades tempranas

RESUMEN: Numerosos estudios han abordado las ventajas cognitivas del bilingüismo, es decir, se ha investigado sobre un mayor potencial cognitivo en personas bilingües, con un desarrollo diferente al neurotípico, lo que conlleva diferentes beneficios. Este trabajo presenta una revisión bibliográfica de artículos publicados en los últimos cinco años donde se analiza cómo el bilingüismo en edades tempranas influye positivamente en el desarrollo cognitivo de los niños y en el desarrollo de las funciones ejecutivas. Para este análisis se tuvieron en cuenta diferentes criterios para discriminar entre los numerosos hallazgos y así asegurar la validez y fiabilidad del estudio. Esta revisión pretende sintetizar los hallazgos recientes, y sugerir implicaciones pedagógicas para fomentar entornos educativos inclusivos y eficaces, promoviendo el desarrollo cognitivo temprano desde la perspectiva de la neuroplasticidad.
Palabras clave: bilingüismo en edades tempranas, rendimiento de los bilingües, niños desarrollo cognitivo de los niños, funciones ejecutivas

1. Introduction

Bilingualism has become an immediate phenomenon for the time being. This fact drives us to question how to approach education, aiming not only to satisfy bilinguals' needs but also to foster their cognitive potential.

Bilingualism is generally and commonly associated with the regular use of a second language. However, the benefits of early bilingualism do not exclusively arise from the acqui-

sition of an L2, but rather from the frequent transition between languages and the mastering of specific domains depending on the language being in use (Calabria et al., 2018). This reason constitutes the starting point of this paper and raises its main question: Does early bilingualism offer measurable cognitive advantages over monolingual children in executive functions such as working memory, inhibition, and cognitive flexibility? Throughout this review, we will examine how these advantages might translate into academic and social improvements over the course of a student's life.

Prior research has indicated that being bilingual may bestow benefits on cognitive function, resulting in enhanced performance, particularly in tasks related to executive control and attention (DeLuca et al., 2020). The view that bilinguals could profit cognitively from their bilingualism is based on the theoretical assumption that bilingual and multilingual individuals experience constant cross-linguistic activation and interaction during language processing (Poarch & Krott, 2019). During communication, both languages are said to be active, even if one of them is not required. Hence, in order to be able to use the correct language in a given situation, there is a need for a cognitive control mechanism that allows speakers to resolve the conflict between actively competing languages. In humans, a cognitive control mechanism for non-verbal processing is already present: the executive function (EF) (Poarch & Krott, 2019). During communication, different regions of the brain related to language are active. In the bilingual case, both languages are said to be active, even if one of them is not required. Hence, in order to be able to use the correct language in a given situation, there is a need for a cognitive control mechanism that allows speakers to resolve the conflict between actively competing languages (Bialystok & Craik, 2022).

Among the so-called executive functions, this article considers the definitions given by Diamond (2020) including working memory (active retention and manipulation of non-perceptually present information), inhibitory control (ability to regulate one's attention, behaviour, thoughts, or emotions in order to counteract a strong internal inclination or external temptation, and instead execute one's intended actions) and cognitive flexibility (adaptation to change and switching between different tasks or mindsets). Regarding this EFs, the more frequent code-switching occurs in daily life, the more cognitive shifting and inhibition development (Han et al., 2022). Moreover, this article will analyze whether this cognitive advantage has greater presence in early bilingualism cases, meaning in cases of bilingual children. In this sense, prior research also specifies that this effect was more pronounced in children under six years old compared to older children, reflecting reflect the rapid cognitive development occurring in younger age groups (Planckaert et al., 2023).

Given the above-mentioned subject matters, the main notion to be analysed and that becomes the core of this review, is whether it could be stated that bilingualism becomes itself a predominant context for neuroplasticity (Bialystok, 2017). Furthermore, and going deeper in the topic, the supposed cognitive advantage of bilinguals will be defined regarding the specific executive functions being bestowed. In this paper we intend to synthesize recent findings and to suggest pedagogical implications to foster more inclusive and effective educational environments, promoting early cognitive development from a neuroplasticity-based perspective.

2. Theoretical framework

Language is not processed the same way in all situations, but it is shaped by the context and the languages being used. For bilingual speakers the interactional context in which they find themselves drives the adaptive response (Green & Abutalebi, 2023).

Bilingualism conveys the use of more than one language in daily life. Bilinguals frequently switch between languages regarding the situations in which they find themselves. The Adaptive Control Hypothesis theorise that there are three main interactional contexts in which bilingual communication can take place (Green & Abutalebi, 2023):

- Single-language context: one language is utilised in one setting and the other in a separate, distinct setting.
- Dual-language context: both languages are employed. Language alternation may happen during a conversation but not within a single utterance.
- Dense code-switching context: speakers frequently mix their languages within a single utterance and incorporate words from one language into the context of the other.

Bilinguals need to select one language instead of the other in a given conversational context. This ability is what we refer to with the term 'bilingual language control' (BLC) (Calabria et al., 2018).

BLC is featured as a set of cognitive processes similar to those proposed for the executive functions or domain-general executive control (EC) system. The EF exposed before are related to specific brain regions interconnected in a network (Calabria et al., 2018). Each part of the brain is active when it is required to fulfil any type of action. Thus, when communicating, many areas of the brain are active at the same time. Nevertheless, for bilinguals it becomes a challenge, since it is well established that multiple languages are jointly activated and compete for selection in a bilingual mind (Frederiksen & Kroll, 2022). In the repertoire of a bilingual individual, both languages remain active to varying degrees, even if one of them is not necessary for the current context. These capacities demand substantial cognitive control to suppress potential linguistic interferences (Calabria et al., 2018). In this article, joint activation will be considered one of the main reasons to talk about bilingualism as a framework for neuroplasticity.

Another key point to consider when studying bilingualism is language dominance and children's proficiency development in two languages. Oppenheim et al. (2020) investigates how bilingual children develop proficiency in two languages over time and how their dominant language can shift due to varying usage contexts. The dominant language refers, in a bilingual context, to the language that is used the most. The tasks used are timed picture naming and vocabulary measures. The former one concerns children being shown pictures and asked to name them as quickly as possible in both of their languages, measuring vocabulary access speed and proficiency. The latest assess the children's vocabulary in both languages to track their lexical development and proficiency over time. The main findings of the research analyse shifting dominance, incremental learning and experience-driven learning. As children transitioned from Spanish-speaking homes to predominantly English-speaking schools, most of them exhibited a shift in language dominance from Spanish to English. Both languages improved over time, thus, language proficiency is influenced by continual practice and ex-

posure. In addition, the study showed that increased use of English did not necessarily lead to attrition in Spanish; instead, both languages could develop simultaneously. A key point of the study is that bilingual children's abilities in each language are strongly related to their usage and practice of that specific language. Improvement in one language does not inherently cause the decline of the other if both are actively used. This research supports the concept of incremental learning, where bilingual proficiency depends on ongoing use and practice rather than just the age of acquisition. Continuous use of both languages can result in their simultaneous development, contradicting the notion that increasing proficiency in one language leads to the attrition of the other (Oppenheim et al., 2020). The same research will be deeply analysed in the succeeding sections.

As mentioned, thanks to the above-explained joint activation, bilingualism becomes itself a suitable context for neuroplasticity. Acquiring and speaking a second language increases demand on the processes of language control for bilinguals as compared to monolingual speakers. The reason is that language control for bilingual speakers requires the ability to constantly maintain the two languages separated in order to avoid interference. Bilingual individuals regularly practise selecting and switching between languages, which likely strengthens their overall executive control processes (Yurtsever et al., 2023). Moreover, other EFs become indispensable: attention regulation and focus, planning and inhibitory control. As it has already been stated, both languages can develop simultaneously if they are continuously used (Oppenheim et al., 2020). Thus, it is fundamental to consider that regardless of the situation in which the bilingual finds themselves, both languages will be activated in the brain just in case they are needed. A continual risk of interference from the non-target language exists, thus, achieving fluent linguistic performance demands that bilingual individuals exert greater demands on a control system compared to monolinguals, even when language production appears equivalent (Bialystok, 2017).

This continuous practice of selecting and switching languages not only strengthens executive control processes but is also considered a key context for neuroplasticity. Neuroplasticity refers to the brain's ability to reorganize and adapt to new experiences, and bilingualism is an excellent example of how this ability can be fostered and enhanced (Oppenheim et al., 2020). The activation of both languages and the need to manage interference enhance cognitive flexibility, a crucial component of executive functions, which in turn reinforces other essential cognitive skills.

To conclude with, bilingualism is not only a linguistic skill but also a constant practice of cognitive control. This ongoing process of activating and managing multiple languages significantly contributes to the brain's neuroplasticity, underscoring the importance of a continuous and active bilingual environment for optimal cognitive development (Oppenheim et al., 2020).

3. Objectives

The current paper consists of a literature review that attempts to introduce several notions and establish relations between them all aiming to reach the idea above mentioned: Is there a cognitive advantage of bilinguals over monolinguals? In addition, a set of carefully selected research will be summarised and commented on in order to reach fair conclusions

about the topic and answer the question proposed as accurately as possible.

Building on existing studies that will be deliberately analysed, this paper aims to describe:

- How does language processing occur in a bilingual mind?
- Why does (early) bilingualism benefit the development of executive functions?
- How do early linguistic experiences shape children's future learning.

4. Method

The present search strategy will commence by utilizing two highly impactful scientific databases: "Web of Science (WOS)" and "Scopus." The search equation employed is as follows: ("Early Bilingualism" OR Bilinguals OR "Bilingual Children") AND (Cognition OR "Executive Functions" OR "Cognitive Development"). Following the aforementioned instructions, a total of 1534 results were obtained in 'WOS' and 1970 in 'Scopus'.

These databases were selected due to their broad impact on scientific research and their rigorous coverage of relevant topics in social sciences, psychology, and education. The combination of both ensures that the review is based on robust and up-to-date research, maximizing the relevance of the findings.

These results will be screened based on the following inclusion criteria:

- Article.
- Spanish and English.
- Last five years: we aim to provide an analysis of reliable and current research that lends credibility to this project.

Secondly, a more in-depth screening is conducted regarding the content of the obtained records. The reasons for this second selection are to ensure consistent results and to follow a fair and effective methodology. For this reason, the research began with a study on the arguments presented by researchers who do not find the results supporting a bilingual cognitive advantage to be fair or consistent: there is no common definition of "bilingual" and "monolingual" across studies, the interaction context is not considered, and finally, the linguistic demands of executive function tasks and procedures differ between studies.

To address these arguments, the studies selected for this review meet criteria that ensure the validity and reliability of their findings: the consideration and subsequent analysis of interaction contexts to distinguish types of bilingualism and cognitive demands, comparison of definitions of "bilingual" and "monolingual," and grouping of various tasks according to the executive functions they assess, all contributing to a robust analysis. Additionally, the selected studies present results obtained with participants from different age groups—infants, children, and adults with different L1 and L2 backgrounds—allowing for varied conclusions with a common component: the cognitive advantage reducing from 3504 to 235 items. At this point we applied the following suitability criteria to the remining articles reducing the number to 16 articles to be considered in this paper.

- main focus on bilingual advantage
- type of tasks used to measure executive functions: contrasts with traditional methods and main tasks explained in the appendix.

- age of the participants + longitudinal studies
- enough participants (sample to reach fair results)

In the flowchart of Figure 1, article selection and screening process to reach the final sample is graphically depicted.

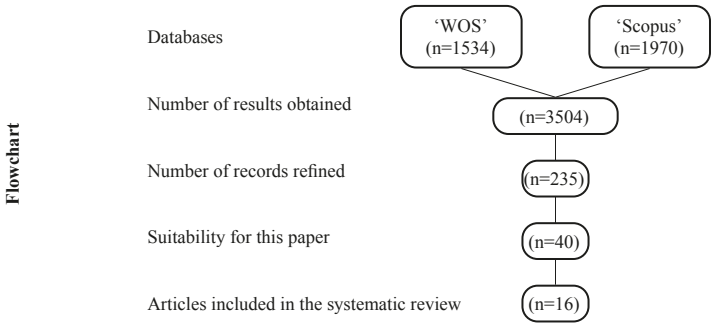

Figure 1. *Flowchart*

5. Results

In this section, we will discuss a series of recent studies selected to provide data that contrast with the ideas mentioned so far while answering to the research ideas (objectives) set.

5.1. How language processing occurs in a bilingual mind

The theoretical framework explained two main notions intertwining in BLC: language dominance and code-switching. To illustrate both notions, two research will be introduced.

Research 1. Language dominance and children's proficiency development in two languages (Oppenheim et al., 2020).

The tasks used are timed picture naming and vocabulary measures. The former one concerns children being shown pictures and asked to name them as quickly as possible in both of their languages, measuring vocabulary access speed and proficiency. The latest assess the children's vocabulary in both languages to track their lexical development and proficiency over time. The main findings of the research analyse shifting dominance, incremental learning and experience-driven learning. As children transitioned from Spanish-speaking homes to predominantly English-speaking schools, most of them exhibited a shift in language dominance from Spanish to English. Both languages improved over time, thus, language proficiency is influenced by continual practice and exposure. In addition, the study showed that increased use of English did not necessarily lead to attrition in Spanish; instead, both languages could develop simultaneously. A key point of the study is that bilingual children's abilities in each language are strongly related to their usage and practice of that specific language. Improvement in one language does not inherently cause the decline of the other if both are actively used. This research supports the concept of incremental learning, where

bilingual proficiency depends on ongoing use and practice rather than just the age of acquisition. Continuous use of both languages can result in their simultaneous development, contradicting the notion that increasing proficiency in one language leads to the attrition of the other (Oppenheim et al., 2020).

The same research will be deeply analysed in the succeeding sections.

Research 2. The effects of habitual code-switching in bilingual language production on cognitive control (Han et al., 2022).

It analyses how frequent code-switching impacts cognitive control among bilingual individuals. The main results illustrate a higher efficiency in frequent language switchers, since bilinguals who frequently switch languages demonstrated higher efficiency in both verbal and nonverbal tasks. The study focuses on Mandarin–English bilingual adults and investigates the consequences of their code-switching habits on cognitive control mechanisms, such as cognitive shifting and inhibition. The research bases its theoretical framework on two of the most known theories about bilingualism: the Adaptive Control Hypothesis (ACH) (Green & Abutalebi, 2023) and Control Process Model (CPM) (Green & Wei, 2014). These theories predict that bilinguals' cognitive control strategies vary depending on their code-switching practices. As it has been explained in previous sections, ACH and CPM propose that different interactional contexts (single-language, dual-language, and dense code-switching) influence cognitive control differently (Han et al., 2022).

The tasks conducted to assess participants were the following ones: verbal fluency task, bilingual picture-naming task, nonverbal colour-shape switching task and Go/No-go task (whack-the-mole task). The main findings show how those that frequently switch between languages are more efficient in both verbal and nonverbal tasks. Specifically, those with intense dense code-switching experience outperformed others in the Go/No-Go task, indicating better inhibitory control. Regarding context-dependent control, the study supports the hypothesis that different code-switching contexts place varying cognitive demands on bilinguals: dense code-switching seems to require lighter control, while dual-language contexts demand more active cognitive control to manage language interference and switch between languages efficiently. The single-language context leads to further exercising of their abilities in goal maintenance and interference control rather than cognitive shifting. Overall, the research underscores the complex relationship between bilingual language use and cognitive control, suggesting that habitual code-switching can enhance certain aspects of cognitive functioning, such as inhibitory control and cognitive flexibility (Han et al., 2022).

5.2. Why (early) bilingualism benefits the development of executive functions.

Research 1. The executive function of bilingual and monolingual children: A technical efficiency approach (Papastergiou et al., 2021).

This research shows how multilingual children exhibit greater proficiency in executive functioning, bolstering the notion that multilingualism (and thus, bilingualism) can improve cognitive capacities (Papastergiou et al., 2021). In this paper, a novel approach to evaluate performance in the executive functioning skills of bilingual and monolingual children is introduced. This approach is based on the frontier methodology that measures the relative efficiency of a decision-making unit (DMU) compared to the best practice, termed as Tech-

nical Efficiency (TE). This approach addresses methodological issues in previous research, aiming for more accurate and efficient analysis. The study utilises Data Envelopment Analysis (DEA) to estimate TE, providing a single efficiency score those accounts for multiple EF tasks. This contrasts with traditional methods that often use separate measures for each task. It allows for more comprehensive group comparisons by accounting for differences between groups by construction (Papastergiou et al., 2021).

The sample of the study includes 32 Greek-English bilingual and 38 Greek monolingual children. Using the accuracy and response times derived from a battery of five executive function assessments encompassing working memory, inhibition, and shifting paradigms, the analysis reveals that individuals within the bilingual cohort demonstrate approximately a 6.5% enhancement in efficiency compared to their monolingual counterparts of Greek descent. This suggests that the bilinguals outperform monolinguals in terms of executive function. Through the implementation of this pioneering TE method, the investigation presents fresh perspectives on how multilingualism might positively impact executive functioning in children and establishes a sturdy foundation for forthcoming research in this domain (Papastergiou et al., 2021).

In Table 1, a fair summary of exposed research is included.

Table 1. *Data summary of the exposed research.*

Authors	Sample & Tasks	Findings
Papastergiou et al. (2021)	32 Greek-English bilinguals 38 Greek monolinguals Working memory, inhibition, and shifting tasks	Bilinguals outperform monolinguals in executive function tasks: 6.5% enhancement in efficiency over monolinguals
Han et al. (2022)	31 Mandarin–English bilingual adults Verbal fluency task, bilingual picture-naming task, nonverbal colour-shape switching task and Go/No-go task	Higher efficiency in frequent language switchers in both verbal and nonverbal tasks. Intense dense code-switching experience carries out an outperformance in Go/No-Go task: inhibitory control. Single-language context: further exercising of goal maintenance and interference control. Dual-language contexts: more active cognitive control to manage language interference and switching (Han et al., 2022).

Several systematic reviews will also be included in this section to offer new perspectives on the topic.

Research 2. Is there a cognitive advantage in inhibition and switching for bilingual children? (Planckaert et al., 2023).

This systematic review groups several studies that point to beneficial effects of bilingualism on executive functioning in children evidence. These results are developed in the table below (Table 2).

Table 2. *Summary of the review by Planckaert, Duyck and Woumans.*

Authors	Main findings
Kovács & Mehler, (2009)	Through three eye-tracking studies with 7-month-old infants, this research illustrates that they outperformed matched monolinguals on cognitive control abilities (Kovács & Mehler, 2009).
Kang & Lust (2019)	This study demonstrates that bilingual language proficiency in 8-year-old children was a predictor for their EF performance (Kang & Lust, 2019).
Tran et al. (2019)	A similar bilingualism effect on cognitive control processes was pointed out by means of measuring selective attention, switching, and inhibition in a longitudinal study with 3- to 4-year-olds (Tran et al., 2019).
Hartanto et al. (2019)	In a large-scale study with 18200 participants, within which children aged 5 to 7 were included, bilingualism was discovered to moderate the impact of socio-economic status (SES) by lessening the harmful effects of low SES on executive functions (EF) (Hartanto et al., 2019).
(Dick et al., 2019)	No evidence for a bilingual executive control advantage was found in a large sample (N = 4,524) of 9–10-year-old who were tested for inhibitory control, attention, task switching, and cognitive flexibility (Dick et al., 2019).

Research 3. Bilingual children outperform monolingual children on executive function tasks far more often than chance: An updated quantitative analysis (Yurtsever et al., 2023).

Yurtsever, Anderson and Grundy offer robust evidence through a meta-analysis that bilingual children consistently outperform their monolingual peers on EF tasks. In their review, they address previous inconsistencies in research by carefully considering sample characteristics and methodological differences, thereby reinforcing the argument that bilingualism enhances cognitive abilities beyond what would be expected by chance. The study is grounded in a strong theoretical framework that explains why bilingualism might enhance EF. Bilingual individuals regularly practise selecting and switching between languages, which likely strengthens their overall executive control processes. Moreover, the finding holds true across various definitions of bilingualism and methods of measuring bilingual experience (Yurtsever et al., 2023).

The paper presents several key facts to demonstrate that bilingual children outperform monolingual children on executive function (EF) tasks. First of all, the study uses a comprehensive meta-analysis, combining data from multiple studies. It includes evidence from both longitudinal studies (which track changes over time, providing insights into how bilingualism affects cognitive development) and cross-sectional studies (compare different groups at a single point in time). This approach provides a more reliable and generalizable conclusion than individual studies. The findings show that bilingual advantages in EF are consistent across different studies, settings, and participant groups. This consistency strengthens the argument that the observed benefits are robust and not due to specific study conditions or sample biases. Bilingual children outperform monolingual children on a range of EF tasks, including those measuring attention, inhibition, working memory, and cognitive flexibility. This suggests that the cognitive benefits of bilingualism are broad and affect multiple aspects of executive functioning. For the study to be considered reliable and fair, it accounts for potential confounding variables such as socioeconomic status, age, and general cognitive ability. By controlling these factors, the study ensures that the observed bilingual advantages in EF are not due to other underlying differences between bilingual and monolingual children (Yurtsever et al., 2023).

One of the reasons mentioned by researchers against the role of bilingualism as a context that enhances EF, is the idea that there is not a consistent and common definition of the bilingual phenomenon across studies. However, this paper considers various definitions and measurements of bilingualism, including language proficiency, frequency of language use, and age of acquisition. This comprehensive approach shows that the cognitive benefits are evident across different types of bilingual experiences (Yurtsever et al., 2023).

Research 4. Is bilingualism related to a cognitive advantage in children? A systematic review and meta-analysis (Gunnerud et al., 2020).

This study offers a different perspective to the ones already explained. The meta-analysis reviewed numerous studies involving children aged 0-18 to determine if bilingual children outperform their monolingual peers in tasks requiring EF. While some individual studies suggest a bilingual advantage, the meta-analysis found that the evidence is mixed and context-dependent. Specifically, the cognitive benefits of bilingualism appear to be influenced by factors such as the age of the children, the specific cognitive tasks used in studies, and the proficiency levels in both languages (Gunnerud et al., 2020).

The meta-analysis reviewed examines a variety of tasks used to measure executive functions (EF) in children, primarily focused on working memory, cognitive flexibility, and inhibitory control: Stroop Task, Simon Task, Flanker Task, Dimensional Change Card Sort Task and Working Memory Tasks. The meta-analysis considers the performance on these tasks across multiple studies to evaluate the presence and extent of any cognitive advantages associated with bilingualism. Overall, the findings indicate that while there may be some cognitive benefits to bilingualism, these advantages are not universally observed across all studies and situations. The paper emphasises the need for more nuanced research to understand under what conditions bilingualism might enhance cognitive abilities in children (Gunnerud et al., 2020).

5.3. How early linguistic experiences shape children's future learning.

Research 1. Longitudinal evidence for simultaneous bilingual language development with shifting language dominance, and how to explain it (Oppenheim et al., 2020).

Longitudinal studies enable researchers to test the same phenomenon during a long period of time. For this reason, this research allows us to examine how the afore-discussed enhancement in executive functions is seen in children across time. Hence, it also illustrates how this development shape future experiences in children's lives. It focusses on how language dominance can shift and the factors contributing to these changes.

The sample concerns 300 children from the Austin Texas metropolitan area who were at the moment in the kindergarten period and Grades 2 and 4. They were tested once per year for up to four years. Given that the paper attempted to discuss shifts in language dominance over time, the ones included in the analysis were the 139 Spanish/English bilingual children for whom they had two or more years of data and whose parents initially reported more than 50% Spanish use at home: all of them grew up in Spanish-dominant homes and most also included some amount of English. The tasks used in the study were Blocked cyclic picture naming and Expressive One-Word Picture Vocabulary Test – Third Edition (EOWPVT-3). The study designed for these 139 children, the task selected are 366 blocked cyclic picture naming sessions in Spanish and 359 in English.

The study provides evidence that language dominance in bilingual children is not fixed but can shift over time. This shift can occur due to changes in the linguistic environment, such as increased exposure to one language over another. Bilingual children exhibit diverse trajectories of language development, with some showing balanced bilingualism while others show varying degrees of dominance in one language. The study highlights that these trajectories are dynamic and subject to change based on the aforementioned factors. The conclusions of the paper argue that

> *experience-driven plasticity is a core feature of all levels of language use and representation. Not only do we continually modify our representations and procedures within a language, dynamically learning and unlearning even well-established words, but we also modify our access to multiple languages. This is because the same kinds of domain-general incremental learning processes operate at every level of the system, yielding experience driven changes. More generally, such effects reflect the kind of basic incremental learning processes that underlie even complex behaviours like language production (Oppenheim et al., 2020).*

These reasons directly relate to the main question of this review, since plasticity and early experiences overcoming several changes in language development will enhance cognitive control (CC).

6. Conclusions

The studies briefly summarised above, along with earlier research on cognitive differences between monolinguals and bilinguals, utilised traditional executive function tasks. While many of these studies found a consistent difference between the groups, some did not, even when structural or functional brain differences were present. However, the central argument of this paper is that, while numerous studies indicate a bilingual advantage and others show comparable performance between monolinguals and bilinguals, it is uncommon for monolinguals to be reported as outperforming bilinguals. Furthermore, it is Grundy who in his own meta-analysis argued "that there are several reasons, often overlooked, that lead to failed replications, and that when group differences do appear on EF tasks, despite these issues, performance favours bilinguals far more often than monolinguals" (Grundy, 2020).

The vast majority of researchers and studies that do not consider fair nor robust the results defending a bilingual cognitive advantage is argued by with the following reasons: no consistent definition of "bilingual" and "monolingual" across studies, no consideration of interactional contexts, and, finally, the linguistic demands of EF tasks and procedures do differ between studies. In order to counterbalance these arguments, the selected research for this review meets criteria that ensure the validity and reliability of their findings: the consideration and subsequent analysis of interactional contexts, the contrast between definitions of "bilingual" and "monolingual," and the grouping of various tasks based on the executive functions they assess all contribute to a robust analysis.

Among the analysed results, a bilingual superiority over monolingual outcomes predominates. The executive functions that have been enhanced by the bilingual condition include the following: inhibitory control is boosted in dense code-switching contexts; goal maintenance and interference control are constantly being worked on in single-language contexts;

task switching and interference control are stimulated in contexts with two languages in use (Han et al., 2022). All these data result in bilingual individuals being 6.5% more efficient than monolinguals (Papastergiou et al., 2021). The continuous and simultaneous practice of language switching and selection in their daily lives allows the experiences of these children to be considered a context for neuroplasticity: their brain's ability to adapt to change and exert higher daily effort fosters a more dynamic and rich brain structure, thus contributing to greater efficiency in cognitive control. Thus, the cognitive benefits of bilingualism are broad and affect multiple aspects of executive functioning.

It is worth mentioning that the age of acquisition of the second language is another highly debated reason by researchers; hence, this study has focused on early bilingualism and aimed to argue in favour of the cognitive advantage in children. Earlier acquisition of a second language is associated with greater advantages in executive functions. Children who acquire their second language at a younger age and maintain high proficiency in both languages tend to perform better on EF tasks. When considering all the evidence, the most compelling support for a bilingual advantage appears to arise from research focusing on very young children and ageing adults. This suggests that bilingualism primarily influences the critical stages of cognitive development and cognitive decline. The development of the cognitive control (CC) system is crucial during childhood, undergoing rapid evolution, particularly between the ages of three to six. Beneficial impacts of bilingualism have been observed in children from infancy up to six years of age.

All the reasons mentioned allow us to conclude with a clear idea: regardless of the magnitude of the difference that defines this cognitive advantage, whether it is more enduring over time or less, or whether it depends more or less on age, the cognitive advantage derived from bilingualism does exist.

Once we have concluded with this main idea, we must question how this influences education. A complete shift in perspective is proposed in teaching bilingual students, starting from the knowledge we have about language processing and how it is organised in a bilingual mind. We should begin with firm and strong notions, creating stable pillars that guide respectful practices in classrooms. If we know that both languages are active during conversations, inferences should be allowed in the early years, as their executive function (EF) is in the process of development; verb conjugation and word choice will be directly influenced by their L1 and L2, so over-regularization of verbs and grammatical rules should be permitted. To promote cognitive development, metacognitive and metalinguistic techniques will be used to create awareness about the mental processes that occur when they communicate and handle information, so that they themselves can identify what is happening, thus developing a potential whose limits are still unknown.

It is also noted that the current literature contains too much variability to allow the systematically analysis of which specific combinations of bilingual experiences lead to the best executive function (EF) outcomes. While predictions can be made for some experience-based factors, others have not been sufficiently studied, or there is not enough theoretical basis to relate them. Consequently, our understanding of how bilingual experience trajectories might modulate the relationship between language and domain-general cognitive control remains limited.

Several methodological concerns that could impact the reliability of the findings need also to be considered. These include publication bias, where studies reporting positive ef-

fects are more likely to be published, and the lack of standardised measures across studies, making direct comparisons difficult. Future work might also incorporate more combinations of linguistic and nonlinguistic measures to comprehensively assess neurocognitive impacts of various bilingual experience trajectories in bilingualism.

With regard to recommendations for future research in this field, it is worth noting that bilingualism research has shifted towards examining individual differences in language experience, presenting an interesting starting point. However, this article suggests a shift in perspective to explore collectively the range of neurocognitive adaptations and experience-based factors that generate them. This review proposes a bilingual adaptation framework where various neurocognitive outcomes emerge to optimize language control and processing. By jointly considering individual language experiences and their related adaptations, we can more comprehensively map the dynamic nature of neurocognitive changes induced by bilingualism.

Future research could explore how bilingualism impacts not only executive functions but also socioemotional skills, particularly in multicultural contexts. It would be valuable to examine whether these benefits translate into greater conflict resolution abilities and social integration in diverse educational settings.

7. References

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