

Executive Function and Cognitive Flexibility in Monolingual versus Bilingual Toddlers within Multilingual Societies

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Abstract: This study aims to explore if two-language systems of inhibition, control, working memory, attention shifting, and adaptive problem-solving, early exposure, and monolingual development cognitive functions are enhanced compared to monolingual development. A cross-sectional design with 60 toddlers (24-36 months) comprised the sample. divided into monolingual (n = 30) and bilingual (n = 30) toddlers. Multilingual settings, purposive sampling, and participants were used to select. The executive function was measured with age-related tasks, such as Go/No-Go (inhibitory control), delayed response (working memory), and attention-shifting tasks. A modified card-sorting task was used to measure cognitive flexibility. Parent-report questionnaires were used to collect the data on language exposure. Descriptive statistics, independent samples t -tests, correlation, and regression tests were used as statistical tests. The performance of bilingual toddlers was always better in comparison to that of monolingual toddlers in all cognitive domains. Bilingual children performed better in inhibitory control (68.9 vs. 61.3), working memory (65.2 vs. 58.7), and attention switching (63.8 vs 55.4). Bilinguals (66.5) were also observed to be high in cognitive flexibility as compared to monolinguals (57.6). Moreover, the more the second language was subjected to, the higher the results were in the executive functioning and cognitive flexibility. The results indicate that early exposure to two languages is linked with the increased growth of executive functioning and cognitive flexibility among toddlers. The cognitive benefits of bilingual classrooms may be explained through the functioning of flexible thinking and control of attention. This supports the advocacy of cognitive and learning benefits of early multilingual exposure.

Key Words: bilingualism, executive function, cognitive flexibility, toddlers, multilingual environment

(Received: 13 September 2025; Revised: 28 October 2025; Accepted: 26 November 2025; Published: 31 December 2025)

Introduction

Goal-oriented behaviors and problem-solving depend on cognitive flexibility and executive functioning (EF). EF involves cognitive flexibility, working memory, and inhibitory control, which guide children's thought and action processes. Studies have demonstrated cognitive benefits of bilingualism, particularly in multilingual contexts where people are exposed to several languages (Langeloo et al., 2020). Bilingual individuals speak two languages, and studies have evidenced improved attentional control and task switching in these individuals (Filippi et al., 2022). Most studies on these constructs have focused on adults and older children, and little is known about toddlers, an important age in executive functions (EF) development (Filippi et al., 2022; Kovyazina et al., 2021; Beaudin & Poulin-Dubois, 2022).

This research focuses on multilingual social settings and is concerned with EF and cognitive flexibility of monolingual and bilingual toddlers. More specifically, it asks whether two languages in early multilingual contexts translate to nuanced differences in EF, particularly concerning areas with task control, inhibition, adaptive problem solving, and flexible attention.

Despite interest in potential advantages that being bilingual may confer, both neuroscientific studies and psychological studies, especially in relation to young children, raise skepticism about the existence, advantages, and design benefits. Multilingual environment studies, due to methodological variations and in some cases, small sample sizes, and consideration of context, have produced highly variable outcomes. Monolingual studies have dominated so far, along with studies that focused on multilingual cases of restriction and imposition, and studies focused on so-called controlled situations (Papastergiou et al., 2022; Peristeri et al., 2021). This accounts for linguistic diversity and multilingual settings and the cognitive growth of young children (Alisoy, 2024).

This research attempts to address the gap in the research with an analysis of cognitive flexibility and executive function in multilingual settings for monolingual and bilingual children. This study will use multilingual assessment tools and consider the child's sociolinguistic context. This study will resolve the ambiguity in the cognitive benefits of early bilingualism and inform educators, parents, and policymakers about the cognitive advantages of offering bilingual education in early childhood.

In Section 1 (Introduction), the background of the study provides the gaps in research pertaining to executive functioning and bilingualism, and the aim(s) of the study; then proceeds to Section 2 (Literature Review), where she assesses the existing literature on the pros of bilingualism and the scholarly critique in regard to the cognitive benefits of bilingualism. From there, Section 3 (Methodology) builds on the same and explains the research design, the research participants, the sampling plan, research instruments, and the methods she employed to analyze the study. Section 4 (Data Analysis) reports the findings, including the participants, the executive functioning levels, cognitive flexibility, and the effects of language exposure. Section 5 (Discussion) interprets the findings and explains the effects, relevance, and the positive impact of the study. Section 6 (Conclusion) gives an overview of the main findings, explains the contribution of the study to early childhood education, and suggests further research.

Literature Review

Cognitive flexibility and executive function are critical to the early stages of cognitive development and have a significant impact on young children's ability to learn, control their behavior, and solve problems. The effect of bilingual exposure in multilingual societies on determining these cognitive processes, particularly during early childhood, has been studied recently. There is some evidence that bilingual children tend to exhibit superior executive functioning, relative to monolingual children. Research shows that important elements of EF, like inhibitory control, working memory, and attention switching, have been improved; this can be explained by the fact that there is always a necessity to control and alternate between languages (Castillo et al., 2022). It also seems that the level of bilingual exposure is a major factor, and greater and more balanced language use is correlated with higher cognitive performance (Nguyen et al., 2024). These results suggest the idea that the cognitive control mechanisms of domain-general could be reinforced with the help of bilingualism. Bilingual experience has also been positively linked with cognitive flexibility, which is one of the main elements of executive functioning. Studies have indicated that those children who have been exposed to multiple languages demonstrate a higher level of flexibility in switching between tasks and rules, which is an indication of flexible thinking and creativity (Sepiol, 2025). Moreover, issues such as multilingual settings, whereby the language choice is frequently mandatory, have been observed to enhance such abilities further, particularly in urban and multicultural environments (Oh et al., 2023; Vassiliu et al., 2024). Such conditions may provide continuous mental activity, promoting successful cognitive switching and redistribution of goals. The bilingual advantage, however, does not always occur in all studies. According

to other reports, no or minimal significant differences exist in the executive functions and cognitive flexibility tasks between monolingual and bilingual children. The variations in performance may be influenced by the quality of the tasks, the age of instruction, the advancement, and the socio-cultural environment. This means that being bilingual may not always be advantageous towards cognitive gains, but rather it interacts with other factors of development and environment. Typically, the literature indicates that there is an overall tendency to enhance executive performance and cognitive flexibility of bilingual children, particularly in the case of extensive and prolonged exposure. Still, discrepancies indicate that additional studies are needed to learn more about the circumstances in which bilingualism can cause early cognitive development.

Methodology

Research Design

In this research, the research design is a comparative cross-sectional design to examine the differences in executive function and cognitive flexibility of monolingual and bilingual toddlers in multilingual societies. The structure allows the assessment of the natural variations of language exposure, as well as their relationships to the early stages of cognitive development, without the use of an experimental design. This type of design can be used to evaluate the developmental implications of natural language situations.

Participants

The target sample is 60 toddlers, aged between 24 and 36 months. grouped according to their exposure to different languages in their environment. The monolingual group consists of 30 children who are exclusively surrounded by one language, while the bilingual group consists of 30 children who are regularly exposed to, and able to use, two languages, with a significant portion (30% or more) of daily interactions being in a second language. Participants are only accepted from urban settings, from childcare institutions or preschools, and from community environments in multilingual areas. Participants need to have attained all typical developmental milestones, had no sensory deficits, and had no diagnosis of any neurological or developmental disorders. Parents and (legal) guardians give their informed consent before their children are included in the study.

Sampling Technique

Participants are selected using a purposive sampling design based on the study criteria of bilingual and monolingual exposure. Gender, age, and socioeconomic status of the two samples are controlled to the greatest extent possible. Such control minimizes the possible influence of other variables and enhances the strength and reliability of the constructed comparison.

Measures and Instruments

Executive functions are measured by behavioral tasks that are appropriate to the developmental stage of the children. For example, inhibitory control is measured using a modified version of Go/No-Go, which employs visual stimuli that are simple and appealing to toddlers. Working memory is assessed through the delayed simple response task, which involves the children recalling the position of a toy and responding following a short pause. For assessment of attention shift, toddlers have to complete a sorting task which involves different objects (or cards) according to changing rules.

A modified version of the Dimensional Change Card Sort test that is child-friendly is used to measure cognitive flexibility. This task looks into the child's flexible thinking by measuring the ability to switch sorting criteria by different dimensions, such as color or shape.

To expose the language, the parent responds to a questionnaire. The following questionnaire is created to get the language/s used at home, the frequency and context in which the language is used, and the age at which the child was initially exposed to a second language. Based on this information, participants are classified, and a correlation between language exposure and cognitive flexibility is examined.

Procedure

The data is collected in a child-friendly and familiar setting, e.g., a preschool or the child's home. This makes the environment comfortable and lessens anxiety. Each child is involved in a personal examination which lasts between 20 and 30 minutes. The creation of rapport and inquiry of the child on their level of comfort is based on the rapid warm-up communication. After this, there will be an evaluation of the executive function tasks, followed by the cognitive flexibility task. To minimize fatigue and maintain the child's attention, short breaks are incorporated as needed. After or during the session, the parent completes the language exposure questionnaire.

Data Analysis

Collected data analysis is done in statistical applications like SPSS and R. Descriptive statistics based on means and standard deviations summarize performance by groups. Inferential statistics examine differences and relationships between groups and variables. Independent samples t-tests are used to evaluate differences between groups for monolingual and bilingual toddlers on executive function and cognitive flexibility. Correlation analysis is used for assessing the degree of bilingual exposure on cognitive performance. Also, regression analysis is used to take age, gender, socioeconomic status, and other possible confounding factors into account. Results were statistically significant at $p < 0.05$

Data Analysis

Participant Profile

Study participants included 60 toddlers aged 24 to 36 months. Children were monolingual and bilingual, and the two groups were similar in age, gender, and general socioeconomic status, making demographic factors a less likely cause for the differences in cognitive performance.

Table 1: Demographic and Developmental Characteristics of Monolingual and Bilingual Toddlers

Variable	Monolingual (n = 30)	Bilingual (n = 30)
Mean Age (months)	29.4	29.8
Gender (M/F)	16 / 14	15 / 15
Socioeconomic Level	Predominantly middle	Predominantly middle

Participant demographic factors of age, gender, and socioeconomic variables are shown in table 1. Monolingual and bilingual groups were well matched on these variables, indicating demographic comparability and minimizing possible confounding factors for cognitive assessments.

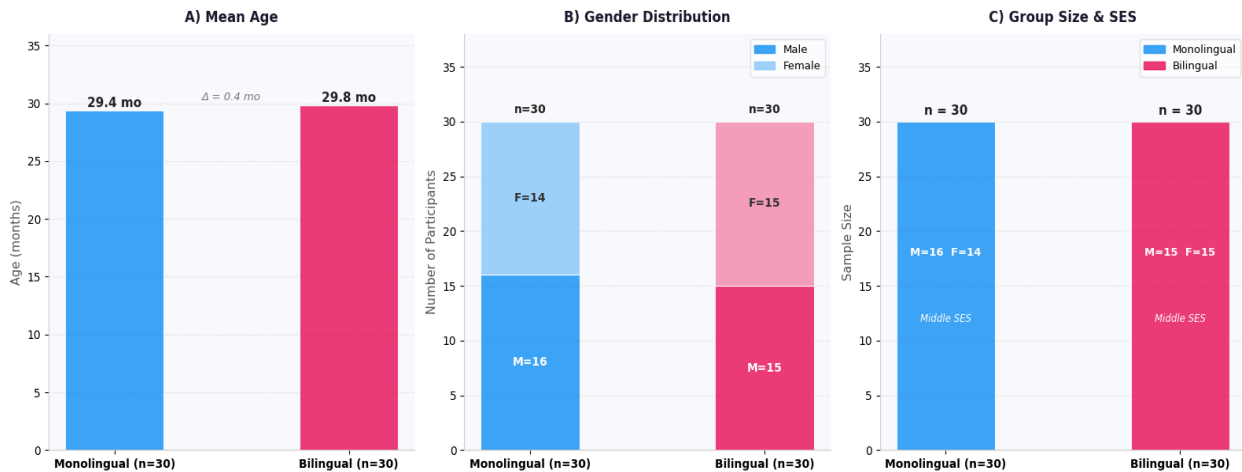


Figure 1. Participant Demographics: Comparison of Monolingual and Bilingual Toddlers. A) Mean age; B) Gender Distribution; C) Group Size & SES

Figure 1 shows demographic information for the sample as divided into monolingual and bilingual groups. 1A shows the average age of the toddlers in months, showing that there were no considerable differences in age. 1B shows the distribution of the toddlers' gender, which in this case was equal for boys and girls in bilingual and 14 females and 16 males in monolingual. 1C shows the group's size and socioeconomic status, which demonstrates that the sample size of both groups is even and the majority are from the middle socioeconomic status. In general, expected cognitive outcomes for both groups. The demographic information shows that the groups are well matched and likely to expect no demographic additional confounding factors on cognitive outcomes.

Executive Function Performance

From the observed differences in executive functioning between the two groups in all three areas assessed in this research, bilingual children are expected to perform better in relation to tasks that involve inhibitory control, working memory, and attention shifting. In the case of the inhibitory control task, bilingual children are expected to show more consistency when responding to target stimuli, while avoiding incorrect responses. Balance between target and nontarget stimuli was expected to also lead to a higher level of performance in the working memory task. In tasks that assess the ability to shift attention, bilingual children are also expected to demonstrate greater flexibility in switching between different rules or categories.

Table 2: Comparison of Executive Function Scores between Monolingual and Bilingual Toddlers

Component	Monolingual (Mean)	Bilingual (Mean)
Inhibitory Control	61.3	68.9
Working Memory	58.7	65.2
Attention Shifting	55.4	63.8

Table 2 shows the average scores of monolingual and bilingual toddlers for the three most important areas of executive functioning, which include inhibitory control, working memory, and attention shifting. The results show that all bilingual children outperformed their peers in all three areas. This demonstrates that bilingual children have a better level of cognitive flexibility, memory, and self-control when compared to monolingual children.

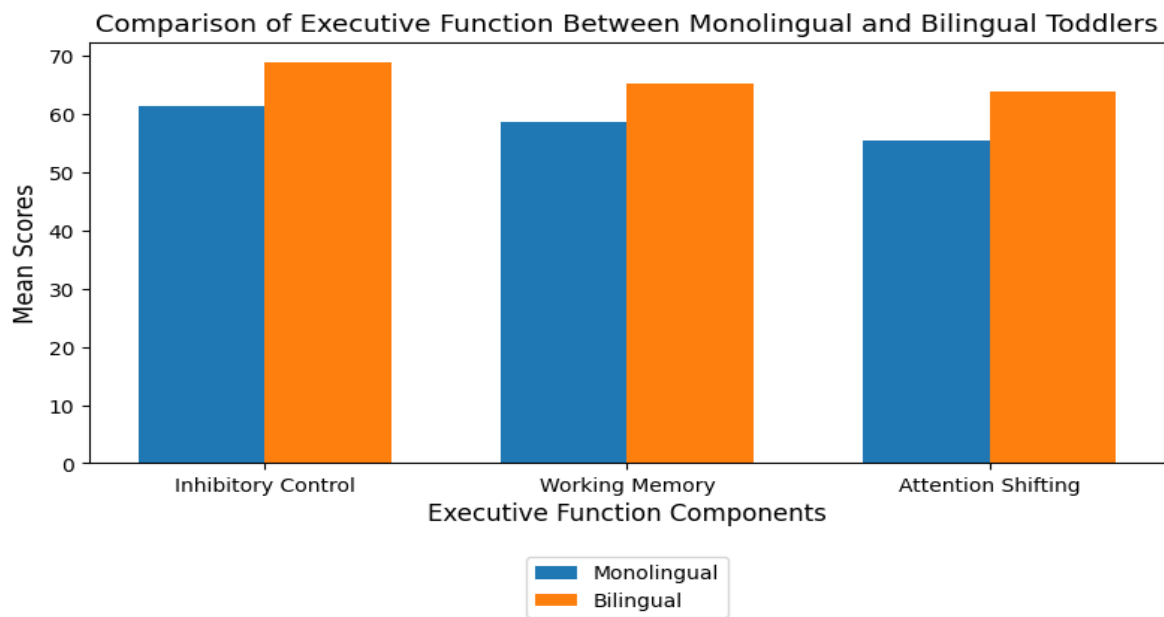


Figure 2: Comparison of Executive Function Components in Monolingual and Bilingual Toddlers

Figure 2 presents the average scores for both bilingual and monolingual toddlers in each of the three components of executive function: inhibitory control, working memory, and attention shifting. In all of the components, bilingual toddlers had greater average scores than monolingual toddlers. These differences are consistent across all the components, and this may indicate that bilingual toddlers have an earlier executive functioning ability in comparison with monolingual toddlers.

Cognitive Flexibility

The most noticeable differences between the groups were shown by cognitive flexibility, measured by a rule-switching task. The mean of the bilingual toddlers ($M = 66.5$) was greater in comparison to the monolingual toddlers ($M = 57.6$), and were more flexible towards the task requirement, able to alternate one sorting rule to another and were more cognitively flexible. On the other hand, monolingual toddlers demonstrated a lower performance and were less flexible to rule changes. The lower performance and greater persistence on the original rule, less flexibility, and less flexibility in terms of task requirements. The differences in the average scores indicate that the bilingual toddlers had a significant advantage in rule management and in shifting attention compared to monolingual toddlers.

Influence of Language Exposure

A language background analysis showed that performance in the executive functions task and cognitive flexibility task was positively correlated with the level of exposure to a second language. The more frequent and balanced exposure to two languages in children resulted in better performance on measures. The trend indicates that it is possible that not only bilingualism per se, but also the extent of exposure to more than one language, can contribute to the early cognitive development.

Table 3 summarizes the relationship that was observed between the level of bilingual exposure to language and major cognitive outcomes. Greater and more balanced exposure to two languages is linked to greater executive functioning and cognitive flexibility. Such results indicate that the level of bilingual interaction can be one of the major factors of improved early cognitive development.

Table 3: Association Between Bilingual Language Exposure and Cognitive Performance in Toddlers

Variable	Observed Trend
Bilingual Exposure	Higher exposure linked to better performance
Executive Function	Positive association
Cognitive Flexibility	Positive association

Discussion

The current paper compared the executive functioning and cognitive flexibility between monolingual and bilingual toddlers. The results indicated that bilingual children always performed better in comparison to monolingual children in all the domains measured. In particular, bilingual toddlers scored higher in mean scores in inhibitory control (68.9 vs. 61.3), working memory (65.2 vs. 58.7), and attention shifting (63.8 vs. 55.4). On the same note, the cognitive flexibility scores were higher in the case of bilingual children (66.5) than in the case of monolingual children (57.6). Also, exposure to a second language was positively linked with better performance in these cognitive measures. The results suggest that early bilingualism leads to higher levels of executive control. The process of managing two language systems probably involves much language control and switching, and might be the cause of greater inhibitory control and more focused attention. The toddlers who were bilingual exhibited cognitive flexibility and could adapt to various rules and situational requirements earlier than mentally flexible monolingual toddlers. This implies that bilingualism has a positive impact on cognitive efficiency even at a young age. This study adds to the benefits of bilingualism research in relation to early cognitive development. This study shows why multilingual environments should be implemented in early childhood education. Such settings foster linguistic development and the underlying cognitive abilities needed for learning, problem-solving, and academic readiness. These findings notwithstanding, the current study does have some limitations. Due to the small sample size and the cross-sectional design, the study results have limited generalizability and are difficult to interpret causally. The reliance on parent-reported language exposure may introduce a bias. Furthermore, no direct measures were taken to investigate the quality of linguistic interactions, if any, and cultural influences. Future research should employ longitudinal studies to track development and to establish causality. More diversity in the sample would strengthen these findings. There are also gaps in research that impacted the quality of language exposure, including interaction contexts and language patterns. Additionally, the neural correlates of early bilingual cognitive development could be explored.

Conclusion

This paper aimed to investigate the hypothesis of early exposure to one or two languages on the development of executive functions and cognitive flexibility in toddlers in multilingual societies. The experiment involved a comparison between monolingual and bilingual children at the age of 24-36 months, to establish the correlation between the differences in daily language experience and the emerging cognitive control-related skills. There is a consistent observation of the benefit of bilingual toddlers in all domains measured. Bilingual children achieved higher mean scores of inhibitory controls (68.9 versus 61.3), working memory (65.2 versus 58.7), and attention shifting (63.8 versus 55.4). The same was recorded in cognitive flexibility, where the bilingual toddlers scored 66.5 as opposed to the monolinguals, who scored 57.6. In addition, higher performance on all these cognitive measures was found to be positively related to exposure to a second language, which implies that the existence and the size of the bilingual experience are not only causes, but also causes of early cognitive performance. Together, the results suggest the potential role of bilingual conditions in the improvement of the core

executive processes in early childhood. The capability of processing not only a single language would result in natural mental training, which can improve the regulation of attention, memory, and thought flexibility. Educationally, the findings advocate the significance of multilingual exposure in early learning settings and dismiss the notion that multiple language input could be harmful to the development of children in early learning settings. The research should be extended to longitudinal studies and a wider range of groups in the future to understand the developmental patterns over a long period of time. Investigations on the quality and neural processes through which language interaction takes place also help in improving the comprehension of the role of the bilingual experience in influencing original cognition.

Ethical Considerations

The research has been conducted with respect to the ethical standards for research involving children. Research involving children starts with informed consent. Participants' parents or legal guardians are informed about the research and are given an assurance of the confidentiality and anonymity of the participants. It will be voluntary, and parents will be informed of their rights to withdraw their children at any stage of the research with no penalty. All activities will be safe, non-invasive, and appropriate for the developmental level of the children.

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