THE EFFECT OF BILINGUAL EXPERIENCE AND HOME LANGUAGE ENVIRONMENT ON COGNITIVE CONTROL OF BILINGUAL CHILDREN

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ABSTRACT

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There has been growing interest in how different dimensions of bilingual experience correlate with cognitive abilities within the bilingual group. This interest targeted data from young bilingual children who lack sufficient language production. The current study includes a variety of bilingual experience-related factors such as language proficiency, language use, and code-switching frequency, as well as targeting both young bilingual children and their parents. Twenty-four multilingual families with 30- to 48-month-old bilingual children provided audio recordings of their daily interaction, filled out the bilingual experience-related questionnaire, and participated in online cognitive tasks. Results showed that children's age, rather than any of the children's or parents' bilingual-experience-related variables, predicted children's cognitive control abilities. We also reported the intercorrelations among all bilingual-experience-related variables for both children and parents. This study is one of the few studies that looked at the bilingual effects between bilingualism and cognition by including parental factors as well as three bilingual-experience-related dimensions, particularly the code-switching frequency. The implications of applying the bilingual experience-based approach and including environmental factors while studying young bilingual age groups with limited language production were also discussed in the article.

Keywords: bilingual experience-related variables, cognitive control abilities, environmental factors, code-switching frequency, young bilingual speakers

ÖZ

İKİ DİLLİ DENEYİM VE EV DİLİ ORTAMININ İKİ DİLLİ ÇOCUKLARIN BİLİŞSEL KONTROLÜ ÜZERİNDEKİ ETKİSİ

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İki dilli deneyimin farklı boyutlarının, iki dilli grup içindeki bilişsel yeteneklerle nasıl ilişkili olduğu konusuna giderek artan bir ilgi vardır. Bu ilgi, yeterli dil üretimine sahip olmayan iki dilli küçük çocuklardan elde edilen verileri hedef almaktadır. Bu çalışma; dil yeterliliği, dil kullanımı ve kod değiştirme sıklığı gibi iki dillilik deneyimiyle ilgili çeşitli faktörleri içermenin yanı sıra hem iki dilli küçük çocukları hem de ebeveynlerini incelemeyi amaçlamaktadır. Günlük etkileşimlerinin ses kaydı alınan, 30 ila 48 aylık iki dilli çocukları olan yirmi dört çok dilli aile, iki dilli deneyimle ilgili anketi doldurdu ve çevrimiçi bilişsel teste katıldı. Sonuçlar, çocukların veya ebeveynlerin iki dilli deneyimleriyle ilgili değişkenlerden ziyade çocukların yaşının, çocukların bilişsel kontrol yeteneklerini yordadığını gösterdi. Ayrıca hem çocuklar hem de ebeveynler için iki dillilik deneyimiyle ilgili tüm değişkenler arasındaki karşılıklı ilişkiler de incelendi. Bu çalışma, iki dillilik ile biliş arasındaki iki dillilik etkilerini, ebeveyn faktörlerinin yanı sıra iki dillilik deneyimiyle ilgili üç boyutu, özellikle de kod değiştirme sıklığını dahil ederek inceleyen birkaç çalışmadan biridir. Çalışmada, sınırlı dil üretimine sahip iki dilli genç yaş gruplarını incelerken iki dilli deneyime dayalı yaklaşımın uygulanmasının ve çevresel faktörlerin dahil edilmesinin sonuçları da tartışılmıştır.

Anahtar Kelimeler: iki dilli deneyimle ilgili değişkenler, bilişsel kontrol yetenekleri, çevresel faktörler, kod değiştirme sıklığı, iki dilli çocuklar

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CHAPTER 1

INTRODUCTION

The global bilingual/multilingual population is growing as the world becomes more interconnected. It was reported that there are about 7000 languages within all 200 countries in the world, therefore smaller language speakers need to use languages other than their native language daily (Cenoz, J. 2013; UNESCO, & UNICEF. 2020, p.2). According to Crystal (1997), bilingualism (mainly the use of English and another language) represents approximately 235 million people worldwide, and two-thirds of the world's children are raised in environments that speak more than one language. Meanwhile, researchers are becoming increasingly interested in the potential association between this unique linguistic capacity and human cognitive abilities.

Nonetheless, for the past decades, whether bilingual speakers have a cognitive advantage over monolingual speakers has been the subject of heated debate up to the present day (Gunnerud et al., 2020; Lowe et al., 2021; van den Noort et al., 2019). Because of the complex and controversial nature of bilingualism and cognition, skeptics assert that “bilingual advantages in executive functioning either do not exist or are restricted to very specific and undetermined circumstances” (Paap et al., 2015).

The current study was designed to address the challenges that researchers face when studying the effects of bilingualism on cognition, as well as the gaps in the literature in terms of age group. Instead of using the popular group comparison between monolingual and bilingual speakers, the focus of this study is to treat bilingual experience related variables of both children and parents as potential indicators of the bilingual effect on children's cognitive control abilities. We hope to disentangle the effect of bilingualism by applying a gradient measure of bilingual experience related factors, including language proficiency, language usage, and code-switching frequency of both bilingual children and their parents. We also hope to focus on the

relatively understudied age group, which is young bilingual children without sufficient language production, and pay attention to parental factors that constitute their home language environments.

The goal of the current study is twofold: 1) to examine whether bilingual experience related factors, particularly code-switching frequency, influence children's cognitive control ability; and 2) whether parental- or child-related factors could potentially account for the variation of young bilingual children's cognitive control abilities.

1.1. Overview

Scholars suggested that the reasons for inconsistent findings about the "bilingual effect" are due to 1) the validity of the tasks for measuring cognitive outcomes that could be impacted by bilingual experience; 2) confounding effects from certain factors such as age and socioeconomic status; 3) differences between children and adults; 4) and most importantly, underdeveloped typology of bilingualism (e.g., life-long balanced vs. later-onset or infrequent use of the non-dominate language) or the measurement of bilingual related experience not being consistently reported across studies (Bialystok, 2017; De Cat et al., 2016; Lowe et al., 2021). As a result, researchers called for a more rigorous approach based on theoretically-motivated hypotheses instead of the widely used between-group quasi-experimental comparison design to address the potential cause of null findings between bilingual and monolingual groups.

One of the more recent approaches that have received increased attention is to locate the individual bilingual differences and underlying working mechanisms that potentially contribute to the presence (or absence) of bilingual advantages in executive functions (Bialystok & Craik, 2022; Yang et al., 2016). Consequently, there is a growing body of literature that emphasizes the source of different cognitive performances between monolingual and bilingual groups by investigating the influence of distinct bilingual experiences (Kang & Lust, 2019; Kheder & Kaan, 2021; Sulpizio et al., 2020; Yow & Li, 2015). Language proficiency and language usage appeared to be two of the aspects that could be extracted from multiple self-reported and standardized measures. They were also reported to be the most frequently

examined features in studies in recent years regarding bilingualism and cognition (Luk, 2013; Surrain & Luk, 2019).

Furthermore, code-switching as one of the bilingual experience facets has gained growing attention in terms of building transparent, consistent, and comprehensive reporting of bilingualism's characteristics (Kałamała et al., 2023; Marian & Hayakawa, 2021). It was suggested that the core of the "bilingual advantage" lies in bilinguals' language-switching behavior which generates the monitoring and inhibiting processes that command the effort of cognitive control (Costa et al., 2009). Studies that include multiple abovementioned dimensions of bilingualism in this line of research were limited and the results appeared to be rather inconsistent (Giguere et al., 2022; Kheder & Kaan, 2021). To account for the full range of bilingual experience, researchers are advocating for the integration of analyses that consider the variability of bilingual experience. (De Cat, 2018; Luk, 2015).

Research identifying the association between bilingual experience and cognitive control ability almost exclusively draws evidence from school-age children and adults. Young simultaneous bilingual individuals with insufficient language production rarely become the target age group for studies investigating the relationship between bilingualism and cognitive functioning (Verhagen et al., 2020). It is commonly accepted that the effect of bilingualism is due to bilingual speakers' frequent language conflicting resolution by focusing attention on the target language meanwhile ignoring interference of the non-target language (Green, 1998; Green & Abutalebi, 2013). Most of the studies only investigated how the bilingual individual's language proficiency, language usage, and code-switching behavior affected their cognitive abilities, which were built on the presumption that they were sufficient on language production. Nonetheless, the same research design does not apply to the age group at early language production stages, such as infants, toddlers, or young children with no or limited language production ability.

Nonetheless, differences between monolingual and bilingual infants and toddlers regarding selective attention, visual habituation, cognitive flexibility, and generic executive function have been repeatedly discovered (Comishen et al., 2019; Kovacs & Mehler, 2009a, 2009b; Poulin-Dubois et al., 2011; Singh, 2015; Verhagen et al., 2020).

These discoveries indicated that other than being generated from direct language production, the bilingual effect could also be due to mere exposure and processing of two languages, namely, language comprehension under the bilingual context (Dijkstra et al., 1998).

Therefore, the parental factors that form the bilingual environment for simultaneous bilingual children should be included if we aim at young age groups and take individual bilingual variabilities into consideration. So far, very few studies have considered parental factors such as parental language proficiency and parental language usage as indicators for bilingual children's cognitive performance (Verhagen et al., 2020). To our knowledge, other facets of bilingualism, such as parental code-switching frequency, have never been investigated in terms of parental variables.

1.2. Bilingual Individual Variability and Cognitive Control

During the language production process of a bilingual speaker, both languages are activated simultaneously in the bilingual brain (Costa et al., 1999; Korll et al., 2014). It is commonly accepted that inhibition is critical in allowing bilingual speakers to exclude inferences from non-targeted languages (Martin-Rhee & Bialystok, 2008; Philipp & Koch, 2009). Several bilingual language and cognitive models are based on this inhibition assumption. Green (1998) depicted the bilingual language production process in his Inhibitory Control Model, from conceptual idea formation to language task schema activation, and then inhibition of non-targeted lexical-semantic representations and activation of targeted linguistic systems. By the same token, the Bilingual Interactive-Activation (BIA) Model suggested a top-down control mechanism for decision and response selection when choosing between activated lexical representations (Dijkstra et al., 1998). With the foundation of bilingual language processing theories, there is growing consensus that the bilingual language control process has recruited domain-general cognitive control, providing strong support for the importance of cognitive control in the language production of bilingual individuals (Hartanto & Yang, 2016; Timmermeister et al., 2020).

To differentiate the quantity of cognitive control that happened during bilingual language production and the effect of individual bilingual variations on cognition, language proficiency, language usage, and code-switching frequency were used as

major indicators when applying the within-group comparison design. Abutalebi and Green (2007) proposed that the proficiency level of a second language results in varied activation of the bilingual brain. They attribute this variability to the ongoing active monitoring, selecting, and inhibiting processes during bilingual language processing. Studies also found that for both monolingual and bilingual preschool children, there is an association between language proficiency, inhibition, and shifting abilities (Iluz-Cohen & Armon-Lotem, 2013). Specifically, it was discovered that students who had mastered their L2 performed significantly better at shifting than those still learning the new language. Meanwhile, language usage, as another dimension of the bilingual experience, focused on the potential effect of the bilingual speakers' language mixing throughout the day on cognitive ability. The more frequently they mix their languages in their daily lives, the more practices they will receive implemented in monitoring, selecting, and inhibitory processes (Costa et al., 2009; Soveri et al., 2011).

Code-switching as the more fine-grained factor compared to language proficiency and usage received increasing interest from researchers dedicated to uncovering the underlying mechanism of bilingual effects. Nonetheless, compared to language proficiency and language usage, studies related to code-switching and its effect on cognition are fairly limited (Surrain & Luk, 2019). Green and Abutalebi (2013) in their Adaptive Control Hypothesis, proposed that code-switching behavior initiates eight cognitive control processes (goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, task engagement, and opportunistic planning). Researchers who applied the ACH model in their studies suggested that cognitive control challenges during bilingual speakers' code-switching behaviors lead to better cognitive performance. So far, most of the studies on the association between code-switching behaviors and executive function have focused on adults; however, similar studies targeting children are overly limited.

To the best of our knowledge, only two studies have examined the possible effect of code-switching behavior on executive functions targeted at bilingual children. One of them discovered that contrary to previous work on adults, code-switching performance did not significantly predict EF performance for eight-years-old children; however, bilingual language proficiency did (Kang & Lust, 2017). The other one is a

longitudinal study, and the findings indicated that the less frequent code-switching behavior of children, in fact, negatively affected their inhibitory control during the preschool period (Kuzyk et al., 2020). This result might be because the function of code-switching behaviors for children, especially when they are at the preverbal stage, is different compared to adults. Therefore, it might not be a valid indicator for judging the growth of their cognitive abilities, which supported the necessity of including factors other than young children's bilingual experience as potential predictors in this field of research.

Along with the growing consensus that bilingualism is a complex and dynamic experience, studies started including and comparing multidimensional aspects of bilingual experience when investigating bilingualism and cognition. Within adult bilinguals, it was discovered that better executive control skills are associated with a more balanced level of language proficiency, and usage (Yow & Li, 2015). From a neurological perspective, bilingual experience, including L2 age of acquisition, proficiency and usage, all modulated the network of brain and language connectivity (Sulpizio et al., 2020). Code-switching frequency was also included and researchers found that the frequency of code-switching instead of the age of acquisition of the second language or the degree of language usage in daily life (all calculated as continuous variables) was related to mixing costs when performing shifting tasks (Soveri et al., 2011). Bilingual speakers who code-switch more frequently made fewer errors when performing the Simon task compared to the ones who code-switching less (Kheder & Kaan, 2021).

Nonetheless, there are still limited studies in the field of bilingualism and cognition investigating and comparing multidimensional features of bilingualism, and the results appear to be inconsistent. One study claimed that language proficiency instead of code-switching predicts the executive function performance of bilingual children (Kang & Lust, 2019). Therefore, one of our main goals is to include all three abovementioned dimensions of bilingualism (language proficiency, language usage, and code-switching frequency) and compare their effects on cognitive control abilities.

Moreover, we will also take the opportunity to investigate the intercorrelations among all three bilingualism dimensions and between children and their parents. Given that

researchers have only recently begun to place a greater emphasis on developing a more accurate and consistent description of bilingualism, language proficiency, language usage, and code-switching frequency were extracted from self-reported and standardized measures as relatively more consensual dimensions of bilingualism (Kałamała et al., 2023; Luk & Bialystok, 2013). It has been discovered that people who use both languages equally also have the same level of mastery of the two languages (Yow & Li, 2015). They also concluded that participants who are equally proficient in both languages tend to switch languages more frequently. It was also reported that the more frequently people use their second language, the higher the code-switching frequency observed (Kang & Lust, 2019). Nonetheless, there are also studies reported that the level of language proficiency is not related to the frequency of code-switching (Kheher & Kaan, 2021), The only study that included both children's and parents' factors reported that not only was there a correlation between children's language use and their language proficiency, but also between children's language use and parents' language use (Verhangen et al., 2020). We took the opportunity to explore this question among all children and parental variables in our study as well.

1.3. Dual Language Home Environment and Cognitive Control of Young Bilingual Children

Bilingual children switch their choice of language constantly based on interlocutors and current situations (Kremin et al., 2021; Smolak et al., 2020). In fact, for bilingual children who grow up in dual-language families the language acquisition processes - language perception and comprehension - start long before they can produce their first word (Werker & Byers-Heinlein, 2008). The updated version of Bilingual Interactive-Activation Model (BIA+ model) suggests that language production and comprehension both result in language-switching effects during bilingual language processing (Dijkstra & van Heuven, 2002). Therefore, according to the model, language comprehension is also cognitively demanding and might affect the cognitive functioning of preverbal infants or young children who grow up in a dual-language home environment.

Yet, applying bilingual experience related indicators when studying bilingual effect does not apply to young bilingual children with limited language production since sufficient language production is the precondition of investigation on language proficiency, language usage, or code-switching behavior (Poulin-Dubois et al., 2021). Nonetheless, whether or not the bilingual effect exists in young age groups has always been an interest of researchers, and between-group comparisons were usually applied to detect differences. In a habitual response to visual rewards study, compared to 7- and 12-months-old monolingual infants, who primarily focused on the original location regardless of the presence of rewards or not, bilingually raised infants were able to switch their eye gaze to the new location where the reward appeared (Kovacs & Mehler, 2009a, 2009b). Another visual habituation task also demonstrated better encoding and recognition memory abilities for 6-month-old infants with bilingual home language environments compared to monolingual counterparts (Singh et al., 2015). These findings call into question the widely accepted assumption that bilingual experience only influences cognitive performance through actual language production. Furthermore, to apply within-group instead of between-group comparison to identify the potential association between bilingualism and cognitive abilities for very young age groups, environmental factors should be the ones that call for more attention.

Parental language inputs within the home environment are directly associated with the young children's language outputs (Branum-Martin, 2014; Hoff et al., 2013). Consequently, the parental factors of parents' bilingual experience should be considered and investigated as the indices that predict the cognitive performance of young bilingual individuals. However, very limited studies examine the effect of home language environments. Verhagen et al. (2017) conducted the first study that included predictors of bilingual experience from both parents and children, then discovered that 24-month-old bilingual children with parents who spoke different languages demonstrated better performance on both the conflict task and a delay of gratification task when compared to their counterparts with parents who spoke the same language. This finding could be seen as preliminary evidence for the potential advantages on children's executive function that are bilingually raised.

To improve the methodology of investigating whether bilingualism affects cognitive abilities of very young bilingual speakers aside from between-group comparison, more

fine-grained indicators need to be identified aside from children's bilingual experience dimensions. In her following study, Verhagen et al (2020) took the language use and language proficiency of both children and parents into consideration regarding their possible effects on children's cognitive abilities. The results indicated an effect on parents' language proficiency and language use, whereas no effect on children's language proficiency and language use. The article concluded that the advantage of cognitive control for bilingual speakers can already be traced back to the language-switching behaviors within their environment starting from a young age. Additionally, the author advised direct measurement of the frequency of language switching and observational studies instead of questionnaires. So far, these two studies are the only ones that included parental factors of bilingual experience as indicators that affect their children's cognitive performance; meanwhile, parental code-switching behavior has never been included as one of those parental factors yet. Verhagen's research only suggested that the parents' code-switching behavior may be the cause of how parents' language proficiency negatively predicted their children's cognitive performance.

1.4. The Present Study

The previous literature has dominantly relied on quasi-experimental designs where bilingual groups were compared to monolingual groups; however, bilingual speakers vary greatly from the proficiency of each language they use to the sequence of their language learning. Therefore, the typological issue of bilingualism has always been criticized. More researchers suggested treating bilingualism as a spectrum instead of categories to reduce confounding factors. In the present study we also applied within-group design instead of between-group design, and investigated the possible relationship between bilingual experience related variables from both children and parents, and children's cognitive control task performance. The main research questions of the current study are as following:

1.How different facets of bilingual experience, including language proficiency, language usage, and code-switching frequency of both young bilingual children and their parents, may associate with one another as well as with children's cognitive control ability.

2. To take the analysis one step further, we asked whether bilingual experience related variables predict children's cognitive performance.

We anticipated that there will be intercorrelations among bilingual experience related variables and also with children's cognitive control abilities. Regarding the prediction of those variables on cognition, based on previous literature (Kang & Lust, 2017; Kuzyk et al., 2020), we anticipated that language proficiency and language usage of both children and parents, but not children's code-switching frequency will predict their cognitive performance. We explored the possible effect of parents' code-switching frequency because it has never been investigated before. Regarding the comparison between different variables, we expected that compared to language proficiency and usage, code-switching frequency will contribute relatively more to the variation of children's cognitive performance because they are more fine-grained factors describing the language switching behaviors that initiate cognitive control processes. We also expected that compared to children's bilingualism variables, parental factors will contribute relatively more to the variation of children's cognitive abilities when performing executive function tasks, which is based on previous findings (Verhagen et al., 2017, 2020) as well as the fact that young children do not produce enough language to reflect the cognitively demanding environment to which they are exposed on a daily basis.

In order to maximize the potential effects and to reflect the heterogeneity of bilingual experience instead of viewing it as a mere inclusion criterion, we recruited a highly heterogeneous bilingual speaker group in terms of language combination, such as English, Turkish, German, Chinese and so on. We also employed natural observation method for data collection to capture and investigate code-switching frequency for the first time in the literature. So far, various studies have tried to utilize different methods such as self-reports to capture the dynamic and complex nature of the language discourse in the bilingual home. Natural observation, as the most ecological option, though time-consuming, enabled us to better capture the dynamic and complexity of the language discourses in the bilingual home. We hope that by applying the nature observation method to record parents' code-switching behavior directly would efficiently increase the effect size of the influence of bilingual environment and behaviors on children's executive functions.

CHAPTER 2

METHOD

2.1. Participants

The sample consists of 24 multilingual families, which include both sides of the parents and their children. Children who participated in the study were between 3 and 4 years old (twelve females; Mage = 3;6; SDage = 0.43; Age Range = 2;7 – 4;2). The participants in this study are from families in which at least one parent spoke more than one language with their children on a daily basis. Both parents and children are participants in the study. The sample size is estimated based on the scale of the bilingual community in Turkey (Türkiye İstatistik Kurumu, 2022). Data from one additional child and three additional adults were excluded for the following reasons: failure to submit the audio recording (n = 2), problem with internet connection (n = 1), and disruption during the online testing sessions (n = 1). We also checked outliers regarding cognitive task scores, and all data were within the scope of three deviations from the mean.

All families speak more than one language at home daily, albeit the proportion of different language usage for all parents vary. Language use in the family is limited to Turkish and one more language, or Turkish and English and one more language, decided by the language configuration of the researchers. The languages used in the household were English (n = 21), Turkish (n = 15), and one of the following languages: Chinese (n = 6), German (n = 3), French (n = 2), Arabic (n = 1), Russian (n = 1), Spanish (n = 1), Cantonese (n = 1), Serbian (n = 1), Bengali (n = 1). Trilingual families that speak more than one language, neither English nor Turkish, were not included in the sample. The proportion of different language usage between parents varies from 100% (one parent, one language) to 20% (parents speak the same language 80% of the time in a day).

Seventy-one percent of families have more than one child, and 50% have other adults interact with their children daily. Twenty-one out of all 24 families enrolled their children into daycare, with an average 14-month duration in total at the time of testing (SD = 11.64). The socioeconomic status of the participating families is from middle to high, with 88% of families' income level above 20,000 TL per month. Regarding maternal education levels, 96% of mothers owned a bachelor's degree or higher.

2.2. Procedure

Families were contacted through social media and snowball sampling and mainly consisted of international families in Turkey. Before data collection, a consent letter was collected from every family through an online meeting. Cognitive control abilities were tested during the online meeting with the researcher. Parents' and children's language proficiency, usage and other demographic information were collected through the simplified version of the Bilingual Language Experience Calculator (BiLEC) (Unsworth, 2013) online survey. Lastly, parents were instructed to record a 15-minute audio recording of their family's daily interaction (including mother, father, and child). Most families recorded the conversations during mealtime or play sessions. After all the tasks were finished, the family received an online Amazon gift card of 150 Turkish Lira, and their child received a certificate for their task performance.

2.3. Measurements

2.3.1. Bilingual Language Experience Calculator (BiLEC)

The BiLEC questionnaire was applied to examine children's and parents' language proficiency and language use. Although this scale is designed to obtain a composite measure of language dynamics in bilingual and multilingual families overall, for our research design, we will only calculate the raw scores on language proficiency and language use for children and parents separately. The BiLEC assessed how children and parents spoke and understood each language on a 6-point scale ranging from 0 ("almost no speaking/understanding") to 5 ("native-like speaking/understanding"). For the measurement of the children, parents were instructed to use estimation by comparing their children's language abilities to those of typical monolingual children of the same age.

2.3.2. Bilingual Experience Related Variables

Six bilingual experience related variables (language proficiency, language use, and code-switching frequency) were created for bilingual children and parents based on the BiLEC questionnaire and audio recordings (See Table 1).

Table 1: Construction of Bilingual Experience Related Variables

Variable	*Explanation*	*Example*
Children's language use	The extent to which children used both home languages in a balanced way versus mainly or only one language in an imbalanced way.	A score of 100 indicated situations in which children either spoke language A 100% of the time to parent 1 and language B 100% of the time to parent 2, or spoke both languages 50% of the time to both parents. A score of 0 indicated situations in which children spoke one language to both parents 100% of the time.
Children's language proficiency	The extent to which they have the same level of mastery in their two home languages versus mainly or only proficient in one language (a higher score does not necessarily mean higher proficiency in both languages, it just means the same proficiency).	A score of 10 indicates balanced proficiency (same proficiency score for both languages), and 0 indicates unbalanced bilingual proficiency (10-point difference in proficiency score between languages).

Children's code-switching frequency	The number of children's code-switching (utterance of children switched from one language to another language was considered one switch, regardless of whether the switch happened between continuous sentences) within one hour.	A score of 100 indicates the code-switching of children occurred 100 times per hour
Parents' language use	The extent to which parents speak the same language(s) to their child versus applying a one-parent-different-language language strategy in the family.	A score of 100 indicated situations where both parents spoke a different language(s) from each other to their child in maximum (e.g., one parent spoke 100% English and the other 100% Turkish), and 0 indicated situations where parents both spoke the same language(s) with the same proportion in general (e.g., both 100% Turkish and 0% English).
Parents' language proficiency	The proficiency level of parents' "weak" language within two or three of the home languages (either their spouses' language or the third language between the couple).	A score of 10 indicated that both parents are native(-like) in their non-native home languages, whereas 0 indicated they have close to no proficiency in their non-native home languages.

Parents' code-switching frequency	The number of parents' code-switching (utterance of parents switched from one language to another language was considered as one switch, regardless of whether the switch happened instantly or from the same or different parents) within one hour.	A score of 100 indicates the code-switching of parents happened 100 times per hour

2.3.3. Code-Switching Frequency for Children and Parents

The recordings were divided into 30-second segments and coded by either English or Turkish-English bilingual research assistants. The 30 second segment is following a common practice for transcribing and coding day-long recordings (Ramírez-Esparza et al., 2014), which ensure the reliability of research assistances when they are required to pay close attention between languages. The research assistants were ensured to have the capacity to comprehend one out of two or two out of three languages documented in the recordings; therefore, the code-switching behavior could be identified and calculated. The research assistants listened to every segment and tagged every time a language change happened as code-switching, and also the direction of the change. The code-switching frequency was calculated based on the number of code-switches per hour of speech for all of families and per 1000 utterance for 13 out of 24 families due to the language capacities of the researchers[1].

[1] Our research assistants are fluent with either Turkish, English or Chinese. We transcribed all utterances from families that used two or three of the abovementioned languages. For the families that speak an additional language other than the above three, only code-switching frequencies were calculated.

2.3.4. Cognitive Performance Tasks

Dimensional Change Card Sort (DCCS) Task. DCCS is a conflict task frequently used to examine the flexibility, switching, and monitoring of attention in Children (Zelazo et al., 2013). Children were required to sort objects with two-dimensional attributes (e.g., red rabbit) based on one of the two dimensions (color or shape) (See Figure 1). The task is conducted with PowerPoint slides through online Zoom meetings. Children were in front of the camera and their parents were next to them or behind them. We first chatted with them to get acquainted with one another and asked for the children's permission to play games with them. Upon their permission, we first displayed two objects on the screen (blue rabbit and red boat), and described them to children focused on either color (red and blue) or shape (rabbit and boat). We then asked them to group the newly appeared objects (red rabbit or blue boat) based on color or shape by pointing to the previously appeared two objects on the screen. To ensure the accuracy of researchers' judgment of the objects that children pointed to, parents were required to assist in the process by raising their hands corresponding to the sides that were pointed. Children accomplished two practice trials and 12 trials in total. In the first six trials children were required to use color for categorization. After the first six trials, the categorization dimension switched to shape for the rest of the trials. Scores were calculated by dividing the total number of correct trials by the total number of completed trials times 100.

Visual Search Task. A visual search task is a task that examines selective attention ability (Mulder et al., 2014). Children were requested to identify the targeted animal image out of 48 images in total per slide. There were three slides in total, with 48 animal images for the first two slides and 72 animal images for the last slide (See Figure 2). Images of elephants, bears, and donkeys that were similar in size and color served as stimuli. During test sessions, children were given 40 seconds to point as many targets (elephants) as they could while ignoring distractions (bears and donkeys). The same as the first task, parents were required to help the researcher locate the images that children were pointed at. All rolls and columns in the slides were numbered for easy recognition of images' location, and researcher crossed off the images that were located by the parents. Scores were counted by dividing the number of accurately identified targets by the total number of targeted animal images within

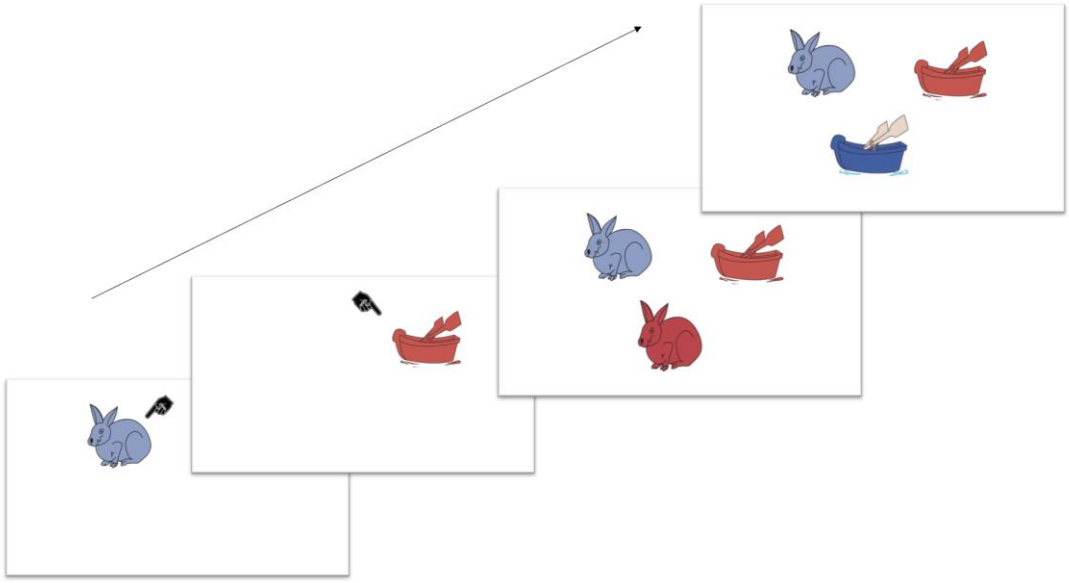


Figure 1: Example of the Dimensional Change Card Sort Task. During the first six trials, children were asked to sort the emerging red rabbit and blue boat based on color (blue or red). For the later six trials, they were asked to sort based on shape (rabbit or boat).

all slides. The internal consistency of the task is relatively ideal (Cronbach's alpha =.80).

2.4. Design & Data Analysis

The current research considered the variation within bilingual children by adopting language proficiency, language use, and code-switching frequency as continuous variables. We first performed correlation analysis to examine the intercorrelation among all variables. Then, we conducted hierarchical regression models to investigate the research question of how different facets of bilingual experience, including language proficiency, language usage, and code-switching frequency of both young bilingual children and their parents, may influence children's cognitive control ability. We want to see specifically whether code-switching frequency as a fine-grained factor affects children's cognitive abilities; for that, we controlled age and the rest of the bilingual-experience-related factors. We also want to see if parental factors act as more dominant indicators compared to children's factors. For that, we controlled age and the children's bilingual-related variables.

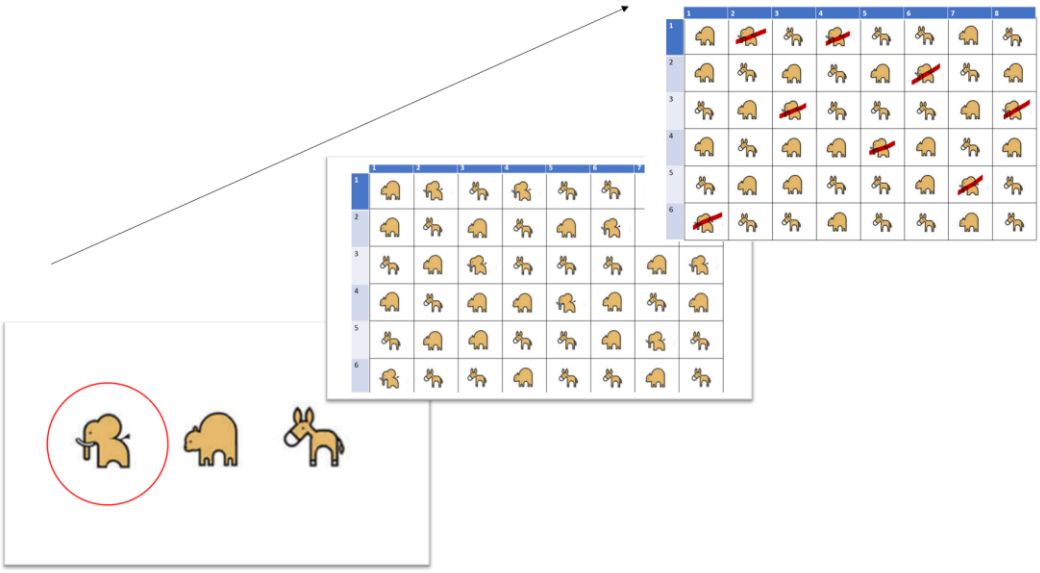


Figure 2: Example of the Visual Search Task. The elephants were crossed off once they were identified by children.

2.5. Results

In total, we collected 324 minutes and 28 seconds of audio recordings from all families who participated and transcribed 4434 utterances for 13 out of 24. For all families on average, parents code-switch behaviors occurred 148 times per hour (SD = 81.70, Range = 24 - 329), while children code-switched 52 times per hour (SD = 46.70, Range = 0 - 162). For the 13 families that we also calculated code-switching frequency based on utterances, parents code-switched 96 times per 1000 utterance (SD = 49.50, Range = 32 - 228), while children code-switched 32 times per 1000 utterance (SD = 46.70, Range = 0 - 104) (See Table 2).

We did correlation analysis for those families whose code switches were measured in two of the abovementioned ways (per hour and 1000 utterances). We found out that for both parents and children, those two types of frequency were highly correlated (rparents = .96, p <.000, rchildren= .91, p < .000). Based on the high correlation between code-switching frequency per hour and code-switching frequency per 1000 utterance, we performed the rest of the analysis by using code-switching frequency per hour for both parents and children (see Kremin et al., 2021 for a similar procedure).

Table 2: Means, Standard Deviations and Minimum-Maximum Scores of Code-Switching Frequency

	N	Mean	Median	SD	Minimum	Maximum
Parents' CS per hour	24	148.3	116.0	81.5	23.5	329
Parents' CS per 1000 utterance	14	95.9	92.2	49.5	31.8	228
Children's CS per hour	24	49.3	43.1	45.8	0.0	163
Children's CS per 1000 utterance	14	32.3	23.1	32.2	0.0	104

We then conducted a t-test to investigate whether or not the gender of the children affects children-related variables. We found no significant difference between male and female children for Dimensional Change Card Sort task score ($t(22) = 1.15$, $p = .26$), Visual Search task score ($t(22) = .68$, $p = .50$), children's language usage ($t(22) = -.73$, $p = .47$), children's language proficiency ($t(22) = -.89$, $p = .38$), children's code-switching frequency ($t(22) = -.82$, $p = .42$).

2.5.1. Relationship Between Bilingualism Related Variables

We first conducted correlation analysis to detect possible associations among children's and parents' code-switching frequency, children's and parents' language proficiency, children's and parents' language use, cognitive task scores, and age (See Table 3.). Results showed that children's code-switching frequency was positively associated with children's language use ($r = .402$, $p = .051$) and negatively associated with age ($r = -.438$, $p = .032$) and parent's language proficiency ($r = -.480$, $p = .018$). Parents' language proficiency was negatively associated with parents' language usage ($r = -.437$, $p = .033$). Children's language usage was positively associated with parents' language usage ($r = .460$, $p = .024$) and children's language proficiency ($r = .419$, $p = .042$). Lastly, children's cognitive task performance was strongly correlated with age ($r_{DCCS} = .559$, $p = .004$, $r_{VisualSearch} = .585$, $p = .003$) but not with any of the bilingual-experience-related variables from both children and parents (all $ps > 0.05$). Descriptive statistics of all bilingual experience variables and children's cognitive control performance can be found in Table 4.

Table 3: Correlation among All Variables

		Cognitive Task (DCCS)	Cognitive Task (Visual)	Children's CS frequency	Children's language proficiency	Children's language usage	Parent's CS frequency	Parents' language proficiency	Parents' language usage	Age
Cognitive Task (DCCS)	Pearson's r	—								
	p-value	—								
Cognitive Task (Visual)	Pearson's r	0.632 ***	—							
	p-value	< .001	—							
Children's CS frequency	Pearson's r	0.014	-0.189	—						
	p-value	0.949	0.376	—						
Children's language proficiency	Pearson's r	-0.108	-0.138	0.059	—					
	p-value	0.617	0.519	0.784	—					
Children's language usage	Pearson's r	0.002	0.036	0.402	0.419 *	—				
	p-value	0.994	0.867	0.051	0.042	—				
Parent's CS frequency	Pearson's r	0.036	0.017	0.113	0.059	0.293	—			
	p-value	0.868	0.936	0.601	0.783	0.164	—			
Parents' language proficiency	Pearson's r	-0.127	-0.095	-0.480 *	0.167	-0.178	0.008	—		
	p-value	0.555	0.658	0.018	0.436	0.405	0.971	—		
Parents' language usage	Pearson's r	-0.322	-0.250	0.288	0.100	0.460 *	0.323	-0.437 *	—	
	p-value	0.125	0.239	0.173	0.641	0.024	0.123	0.033	—	

Table 3 (Continued)

		Cognitive Task (DCCS)	Cognitive Task (Visual)	Children's CS frequency	Children's language proficiency	Children's language usage	Parent's CS frequency	Parents' language proficiency	Parents' language usage	Age
Age	Pearson's r	0.559 **	0.585 **	-0.438 *	-0.110	-0.132	-0.216	0.001	-0.383	—
	p-value	0.004	0.003	0.032	0.608	0.540	0.311	0.998	0.064	—

Note. * p < .05, ** p < .01, *** p < .001

Table 4: Means, Standard Deviations and Minimum-Maximum Scores of Bilingual Experience variables & Children's Cognitive Performance

	N	Missing	Mean	Median	SD	Minimum	Maximum
Parents' language usage	24	0	60.0000	60.000	28.893	20	100
Parents' language proficiency	24	0	6.4167	6.500	1.792	2	10
Parent's CS frequency	24	0	147.9800	116.000	81.735	23.48	328.96
Children's language usage	24	0	51.6667	50.000	26.811	0	100
Children's language proficiency	24	0	7.7500	8.000	2.400	2	10
Children's CS frequency	24	0	51.8462	47.715	46.668	0.00	162.61
DCCS (raw)	24	0	77.4583	79.000	20.398	33	100
Visual(raw)	24	0	42.4167	42.000	12.769	16	79
Cognitive task score (DCCS+visual)	24	0	0.0529	0.135	0.890	-1.63	2.01
Age	24	0	3.6029	3.555	0.433	2.71	4.23

Next, we tried partial correlation analysis between children's code-switching frequency and cognitive performance while controlling children's age as a covariate (See Table 5). The partial correlation coefficient appeared insignificant after considering the effect of children's age.

Table 5: Partial Correlation between children's code-switching frequency and cognitive performance

		Children's CS frequency	Cognitive Task (DCCS)	Cognitive Task (Visual)
Children's CS frequency	Pearson's r	—		
	p-value	—		
Cognitive Task (DCCS)	Pearson's r	0.347	—	
	p-value	0.105	—	
Cognitive Task (Visual)	Pearson's r	0.092	0.453	—
	p-value	0.678	0.030	—

Note. controlling for 'Age'

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

2.5.2. What Predicts Children's Cognitive Control Abilities?

We then examined our main question which is whether or not the bilingual-experience-related variables of parents and children predict children's cognitive control abilities. In total, we conducted five hierarchical regression models. Each model consisted of three steps with the combined score of Dimensional Change Card Sort and Visual Search tasks as outcome variables. The combined score here is calculated as the average score of the sum of two tasks' scores which are converted z-scores of the original raw scores. The first step of each model contained age. Due to the size of our sample, instead of inputting all the remaining bilingual experience-related variables of both children and parents as second steps of the models for controlling purposes, we separated those variables into five sets to increase the statistical power of the analysis. Therefore, the second steps for the five models contained children and parents' language proficiency (model 1), children and parents' language usage (model 2), children's language proficiency (model 3), children's language usage (model 4), and children's code-switching frequency (model 5) respectfully. Due to the main interest

of the study (whether code-switching frequency is more dominant than other bilingualism-related variables, and whether parental factors are more dominant than children's factors), we inserted code-switching frequency of both children, and parents as third steps for models 1 and 2, and parental factors (parents' language proficiency, language usage and code-switching frequency) as third steps for models 3, 4 and 5.

We first did assumption checking, and the result indicates that there is no significant autocorrelation nor collinearity in our data, and residuals are normally distributed (Durbin-Watson statistic = 1.36, VIF values ranged from 1.2 to 1.8, Shapiro-Wilk statistic: W = 0.97, p = 0.67). We continued the rest of the analysis (See Table 6).

Model 1 included age at testing at the first step. We added parents' and children's language proficiency at the second step, and parents' and children's code-switching frequency at the third step. The model was significant at every step (F_{step1} (1, 22) = 14.71, $p_{step1} < 0.001$, F_{step2} (3, 20) = 4.79, $p_{step2} = 0.011$, F_{step3} (5,18) = 3.24, $p_{step3} = 0.029$) explaining 40%, 42%, and 47% of the total variance respectively. In all steps, the only significant variable was age at testing ($\beta_{step1} = 0.633$, $p_{step1} <0.001$, $\beta_{step2} = 0.628$, $p_{step2} = 0.002$, $\beta_{step3} = 0.755$, $p_{step3} = 0.001$).

Model 2 included age at testing at the first step. We added parents' and children's language usage at the second step, and parents' and children's code-switching frequency at the third step. The model was significant at every step (F_{step1} (1, 22) = 14.71, $p_{step1} < 0.001$, F_{step2} (3, 20) = 5.06, $p_{step2} = 0.009$, F_{step3} (5,18) = 3.53, $p_{step3} = 0.021$) in explaining 40%, 43%, and 50% of the total variance, respectively. In all steps, the only significant variable was age at testing ($\beta_{step1} = 0.633$, $p_{step1} <0.001$, $\beta_{step2} = 0.591$, $p_{step2} = 0.004$, $\beta_{step3} = 0.671$, $p_{step3} = 0.003$).

Model 3 included age at testing at the first step. We added children's language proficiency at the second step, and parents' language proficiency, usage and code-switching frequency at the third step. The model was significant at every step (F_{step1} (1, 22) = 14.71, $p_{step1} < 0.001$, F_{step2} (3, 20) = 7.16, $p_{step2} = 0.004$, F_{step3} (5,18) = 3.50, $p_{step3} = 0.022$) in explaining 40%, 41%, and 49% of the total variance, respectively. In all steps, the only significant variable was age at testing ($\beta_{step1} = 0.633$, $p_{step1} <0.001$, $\beta_{step2} = 0.626$, $p_{step2} = 0.001$, $\beta_{step3} = 0.578$, $p_{step3} = 0.006$).

Model 4 included age at testing at the first step. We added children's language usage at the second step, and parents' language proficiency, usage and code-switching frequency at the third step. The model was significant at every step (F_{step1} (1, 22) = 14.71, $p_{step1} < 0.001$, F_{step2} (3, 20) = 7.35, $p_{step2} = 0.004$, F_{step3} (5,18) = 3.73, $p_{step3} = 0.017$) in explaining 40%, 41%, and 51% of the total variance, respectively. In all steps, the only significant variable was age at testing ($\beta_{step1} = 0.633$, $p_{step1} < 0.001$, $\beta_{step2} = 0.628$, $p_{step2} = 0.002$, $\beta_{step3} = 0.755$, $p_{step3} = 0.001$).

Model 5 included age at testing at the first step. We added children's code-switching frequency at the second step, and parents' language proficiency, usage and code-switching frequency at the third step. It was significant at every step (F_{step1} (1, 22) = 14.71, $p_{step1} < 0.001$, F_{step2} (3, 20) = 8.27, $p_{step2} = 0.002$, F_{step3} (5,18) = 3.70, $p_{step3} = 0.018$) in explaining 40%, 44%, and 51% of the total variance, respectively. In all steps, the only significant variable was age at testing ($\beta_{step1} = 0.633$, $p_{step1} < 0.001$, $\beta_{step2} = 0.730$, $p_{step2} < 0.001$, $\beta_{step3} = 0.656$, $p_{step3} = 0.006$).

Table 6: Differential contributions of Age, Language Proficiency, Language Usage, and CS Frequency on the combined score of DCCS and Visual Search Perform

Model 1

Outcome: Cognitive Task Performance					
Predictors	*B*	*SE(B)*	*B*	*p*	*R2*
Step 1				<0.001	0.401
Age at Testing	1.30	0.340	0.633	<0.001	
Step 2				0.011	0.418
Age at Testing	1.292	0.353	0.628	0.002	
Parents' language proficiency	-0.057	0.086	-0.116	0.512	
Children's language proficiency	-0.018	0.065	-0.048	0.785	
Step 3				0.029	0.474
Age at Testing	1.554	0.412	0.755	0.001	
Parents' language proficiency	0.005	0.103	-0.010	0.960	
Children's language proficiency	-0.028	0.065	-0.074	0.677	
Parent's CS frequency	0.002	0.002	0.173	0.338	
Children's CS frequency	0.004	0.004	0.213	0.360	

Model 2

Outcome: Cognitive Task Performance					
Predictors	*B*	*SE(B)*	*β*	*p*	*R2*
Step 1				<0.001	0.401
Age at Testing	1.30	0.340	0.633	<0.001	
Step 2				0.009	0.432
Age at Testing	1.217	0.376	0.591	0.004	
Parents' language usage	-0.005	0.006	-0.170	0.415	
Children's language usage	0.006	0.006	0.177	0.363	
Step 3				0.021	0.495
Age at Testing	1.451	0.472	0.671	0.003	
Parents' language usage	-0.006	0.006	-0.201	0.341	
Children's language usage	0.002	0.007	-0.057	0.788	
Parent's CS frequency	0.002	0.002	0.205	0.275	
Children's CS frequency	0.004	0.004	0.223	0.286	

Table 6 (continued)

Model 3						Model 4					
Outcome: Cognitive Task Performance						Outcome: Cognitive Task Performance					
Predictors	*B*	*SE(B)*	*β*	*p*	*R2*	Predictors	*B*	*SE(B)*	*β*	*p*	*R2*
Step 1				<0.001	0.401	Step 1				<0.001	0.401
Age at Testing	1.30	0.340	0.633	0.003		Age at Testing	1.30	0.340	0.633	<0.001	
Step 2				0.004	0.405	Step 2				0.004	0.412
Age at Testing	1.287	0.348	0.626	0.001		Age at Testing	1.332	0.347	0.647	<0.001	
Children's language proficiency	-0.025	0.063	-0.068	0.694		Children's language usage	0.004	0.006	0.106	0.536	
Step 3				0.022	0.493	Step 3				0.017	0.509
Age at Testing	1.189	0.383	0.578	0.006		Age at Testing	1.169	0.378	0.568	0.006	
Children's language proficiency	-0.007	0.064	-0.019	0.914		Children's language usage	0.005	0.006	0.145	0.455	
Parents' language proficiency	-0.121	0.098	-0.244	0.234		Parents' language proficiency	-0.124	0.094	-0.250	0.204	
Parents' language usage	-0.009	0.007	-0.278	0.222		Parents' language usage	-0.011	0.007	-0.345	0.149	
Parent's CS frequency	0.003	0.002	0.247	0.189		Parent's CS frequency	0.002	0.002	0.223	0.233	

Table 6 (continued)

Model 5

Outcome: Cognitive Task Performance					
Predictors	*B*	*SE(B)*	*β*	*p*	*R2*
Step 1				<0.001	0.401
Age at Testing	1.30	0.340	0.633	<0.001	
Step 2				0.002	0.441
Age at Testing	1.503	0.374	0.730	<0.001	
Children's CS frequency	0.004	0.003	0.222	0.235	
Step 3				0.018	0.507
Age at Testing	1.349	0.437	0.656	0.006	
Children's CS frequency	0.003	0.004	0.159	0.480	
Parent's language proficiency	-0.080	0.112	-0.161	0.484	
Parent's language usage	-0.008	0.007	-0.257	0.251	
Parent's CS frequency	0.003	0.002	0.237	0.201	

CHAPTER 3

DISCUSSION

In this study, we included a variety of bilingual-experience-related factors such as language proficiency, language use, and code-switching frequency to identify the underlying mechanism of the "bilingual effect." Specifically, factors from young bilingual children and their parents were investigated with the assumption that when studying potential cognitive effects on bilingual speakers without sufficient language production, environmental factors (parental indices of bilingualism) should also be considered We first examined the intercorrelation of different facets of bilingualism, including language proficiency, language use, and code-switching frequency from young bilingual children and parents. Then, we analyzed whether or not the abovementioned factors predict children's cognitive control abilities. To our knowledge, this is the first study involving all three bilingualism dimensions with the consideration of environmental factors and calculating code-switching frequency through natural observation.

Overall, results showed that bilingual experience-related variables are correlated not only among children or parents themselves (e.g., children's language proficiency correlated with language usage) but also between children and parents (e.g., children's code-switching frequency correlated with parents' language proficiency). However, age but not bilingual experience-related variables strongly predict children's cognitive control abilities.

3.1. Intercorrelations among Bilingual Experience Related Variables

Due to the need to retain a pragmatic representation of the bilingual experience, the bilingualism-related factors extracted from the existing database or specific study design are allowed to correlate with one another in the analysis. It argued that a network model would be more applicable to the most central indices of bilingualism,

such as language proficiency, language usage, and code-switching frequency, along with other factors, to form a complex pattern of relationships (Kałamała et al., 2023).

In line with the constructs of these factors, we discovered a variety of correlations among studied variables. Firstly, it has demonstrated that the more evenly children use their home languages, the younger the children, and the less proficient their parents' second home language, the more frequently children switch from one language to another daily. The negative association between children's age and code-switching frequency is consistent with the previous study (Kuzyk et al., 2020) explained that children switch between languages due to lacking proficiency instead of balanced mastery of the two languages (Ribot & Hoff, 2014). They need to "borrow" words or sentences from their dominant language to fill in the language gap while expressing with non-dominant language; therefore, the behavior of language switching is reduced once they acquire better mastery of their weaker language.

Moreover, the negative correlation between parents' second home language proficiency and children's code-switching frequency could be due to the context of the participating families in the current study. We observed that in families where parents speak different native languages, the lack of fluency in each other's language between the couple created a natural "one parent, one language" conversation environment where children are accustomed to speaking with parents in different languages. This correlation provided strong support for the discovery in one of the previous studies suggested that bilingual children perform better on a selective attention task when one or two of their parent(s) showed a low level of language mastery in their weaker home language compared to the parents who have balanced proficiency (Verhagen et al., 2019). The authors suggested that parents' language proficiency in their home languages might act as a proxy for their young bilingual children's language switch, which is a more fine-grained factor that enhances children's cognitive abilities. This assumption has been supported in our current findings.

Another interesting finding indicated that whether or not children use their home languages in a balanced way is positively associated with whether children have equal mastery of those languages and whether parents apply the "one parent, one language" policy. On the other hand, whether or not parents use languages differently from each

other is also determined by their second home language proficiency, as well as whether or not children use both home languages evenly. Specifically, for children, the more balanced proficiency of their two languages, the more evenly they will use them. In contrast, for parents, the less proficient in their second home language, the more evenly two home languages will be used at home. These findings suggested that, for both children and their parents, their language usage pattern is decided by their mastery level and their interlocutors' language usage pattern, consistent with what we observed during the investigation. Children or parents both initiated language switches; in either case, the interlocutors were consistent with one another in their language use during each interaction.

3.2. Effect of Bilingual Experience Related Variables on Children's Cognitive Control Abilities

We also investigated whether bilingual experience related factors (particularly code-switching frequency) influence children's cognitive control ability and whether parental or child factors could potentially account for the variation of young bilingual children's cognitive control ability. Our results indicated that only the children's age appeared to be a strong predictor of their cognitive performance. We were able to narrow our focus by using hierarchical regression to examine the individual effects of code-switching frequency as well as parental factors. Yet, we still found no significant result. In other words, our assumptions that the environmental factors or the more fine-grained code-switching factor might act as stronger predictors compared to children's factors or other bilingual experience related variables were not supported.

The small sample size could be one of the reasons why no effect was found other than children's age. Because of the language feature of Turkey in terms of linguistic homogeneity, we established our target participants group within the international community in Turkey, which inevitably affected the potential sample size of our study. Moreover, although the study has been carefully designed to avoid the confounding factors that were advocated by leading researchers in the field (Bialystok & Shorbagi, 2021; Luk & Grundy, 2022) such as SES and different bilingual experiences, there are still the possibilities of unmeasured variables which could affect children's cognitive performance, such as nonverbal intelligence. Although most bilingual effect research

rarely reports their measure of nonverbal intelligence, some studies did control this factor by assessing participants with nonverbal spatial reasoning tasks (Bialystok & Shorbagi, 2021; Treffers-Daller et al., 2020). Additionally, although it appears to be a common, even encouraged practice to recruit participants with different linguistic and cultural contexts (Verhagen et al., 2020; De Cat et al., 2018), the cross-linguistic and cross-cultural effects have not been systematically studied in this line of research. Those potential effects could impact both parents and children's bilingual experience, which in turn potentially affect children cognitive performance.

It is also possible that our methods of measuring bilingual experience, which are based on natural observation, did not accurately reflect our participants' actual language practices. It was recommended in the previous literature to apply natural observation outside of the laboratory to document bilingual speakers' switch between languages in daily life (Kuzyk et al., 2020). However, in the current study, the audio recording only managed to capture a snapshot of the code-switching scenario instead of real-time documentation of a prolonged period. Specifically, due to the limitation of the preset timeframe, although parents have been informed prior to recording that the conversation should be natural and spontaneous, it has been observed that certain parents were pressured to generate topics and consciously cautiously select languages. So even though the natural observation method in the current study is an explorational step compared to measuring code-switching frequency through survey, it might still not be sufficient enough to be considered as a valid indicator of code-switching behavior. So far there are only a few existing code-switching scales invesitgating parental estimation of children's and parental code-switching behavior (Kremin et.al., 2021). Nonetheless, the scale score only explained 14% of the variance in terms of parents' code-switching frequency. As a result, in comparison to the reliability and validity of parent reports on children's vocabulary or specific aspects of morphology and syntax (Fenson et al., 1994), the development of scales for parental estimation of code-switching for both children and parents appeared to require further refinement.

Therefore, the results of our study did not support the existence of a bilingual effect. A meta-analysis suggested that the overall effect size of the bilingual advantage is marginal (Gunnerud et al., 2020). It has also been reported that the potential impact of speaking more than one language on cognitive performance, if it exists, will be

challenging to detect and also limited to specific circumstances (Lowe et al., 2021; Paap et al., 2015). Our findings might provide further evidence that bilingualism does not affect cognitive control ability. Nonetheless, it might also be because improving cognitive control abilities requires continuous challenge (Diamond & Ling, 2016). According to the Inhibitory Control Model and Bilingual Interactive-Activation Model (Dijkstra et al., 1998; Green, 1998) the processes of inhibiting the non-targeted language or choosing from more than one activated lexical system will recruit domain-general cognitive control which leads to the potential effect on cognition of bilingual individuals. However, language switching within families may become automated when the speaking pattern matures and no longer requires top-down cognitive control. If that is the case, it would be beneficial to design a longitudinal study on young bilingual children and their families to document children's language development, especially the code-switching pattern from emerging, to the more accustomed interactive pattern, in the hope of identifying the "specific and undetermined circumstances" that could lead to the potential cognitive effect.

In addition, the current study contributed to the limited literature about the bilingual effect that considered the heterogeneous characteristics of bilingual speakers by including multiple dimensions of bilingualism. It added to the primary foundation toward disentangling the properties of an individual's bilingual experience and uncovering the underlying mechanism by investigating which properties could potentially contribute to enhancing cognitive control ability. The shifting of the attention in the field from group comparison between monolingual and bilingual groups to studying whether more fine-grained facets of bilingualism could predict the bilingual effect has been advocated by pioneering researchers in the field (Bialystock & Craik, 2022). By identifying the composite of bilingualism and associating those indicators to cognitive abilities through regression, we might be able to see the various potential underlying mechanisms more in-depth. Though insignificant, the result of the current study will add more reference to this line of research, which is still growing.

Furthermore, our study is one of the very few studies that included the environmental factors of young bilingual speakers with limited language production. We proposed a solution on how to investigate the bilingual groups with limited language production using a within-group research design, which involves parental factors. Though we did

not detect connections between bilingualism-related factors and cognitive performance in this study, targeting the younger age group as well as the language environment they are exposed to instead of only considering language production as possible indicators is a complementary perspective and taps into the domain of pure environmental influence on cognition developing system in the field of bilingualism and cognitive control abilities.

3.3. Conclusion

In this study, we explored the “bilingual effect” by investigating language proficiency, usage, and code-switching in young bilingual children and their parents. Despite finding correlations between these factors, we discovered that children's age, rather than their or parents’ bilingual experience, strongly predicted children's cognitive control abilities. While our results did not show a clear bilingual advantage, they highlighted the intricate relationships between bilingualism-related aspects and suggested that environmental factors should be considered for young bilingual speakers in the line of research concerning bilingualism and cognition. Our study contributes to the evolving understanding of bilingualism’s impact on cognition for different age groups. It emphasizes the need for nuanced and longitudinal research to unveil the circumstances under which bilingual effects might emerge.

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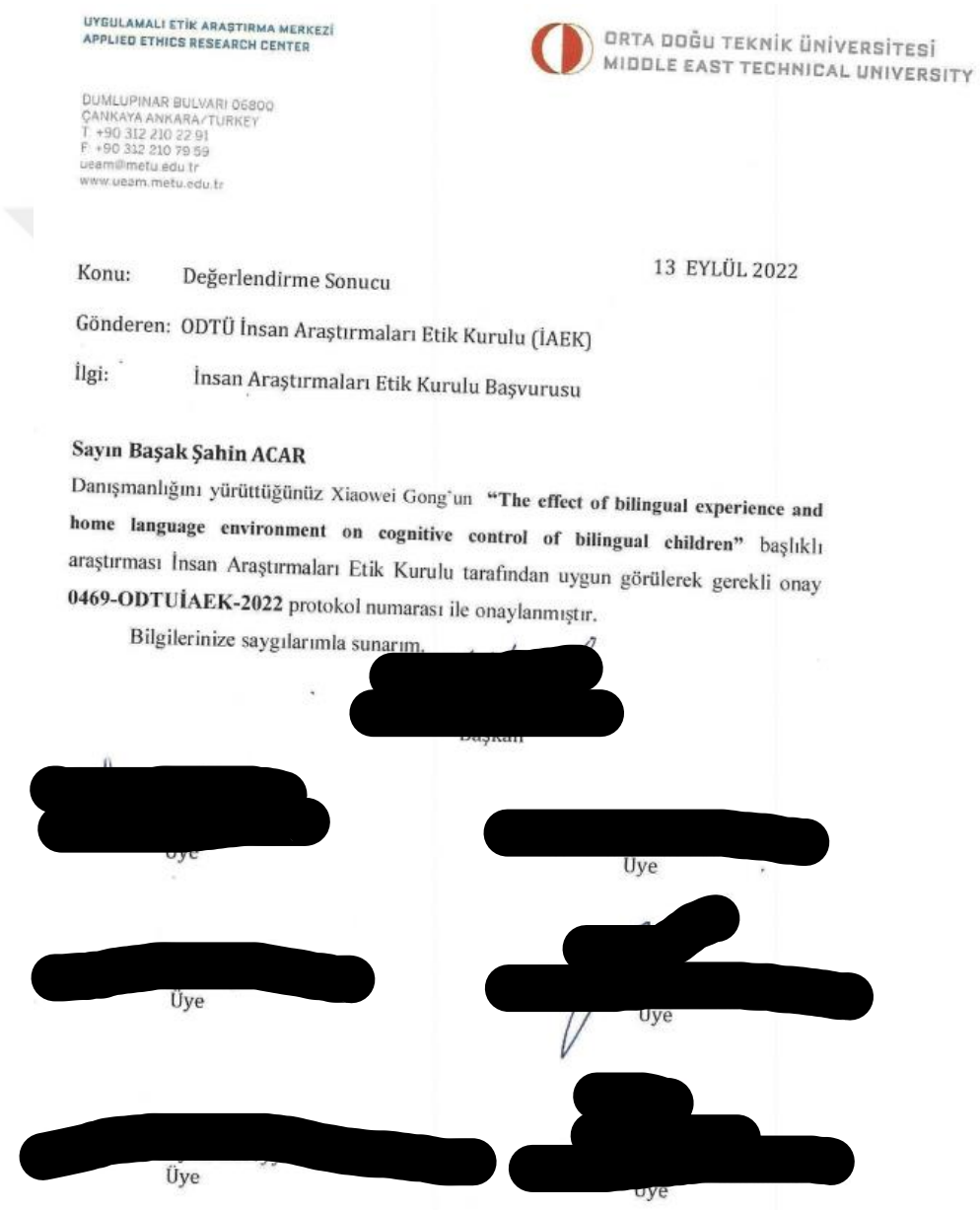
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APPENDICES

A. APPROVAL OF THE METU HUMAN SUBJECTS ETHICS COMMITTEE



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MIDDLE EAST TECHNICAL UNIVERSITY

Konu: Değerlendirme Sonucu

13 EYLÜL 2022

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Başak Şahin ACAR

Danışmanlığını yürüttüğünüz Xiaowei Gong'un **"The effect of bilingual experience and home language environment on cognitive control of bilingual children"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **0469-ODTUİAEK-2022** protokol numarası ile onaylanmıştır.

Bilgilerinize saygılarımla sunarım.

[redacted]

Başkan

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B. BILINGUAL EXPERIENCE QUESTIONAIRE

Background information

1. Your name
2. Child's gender
3. Child's date of birth
4. When did your child start listening to two or more languages?
   - ☐ From birth
   - ☐ After 1-year-old
   - ☐ After 2-year-old
5. Does your child have brothers and/or sisters?
6. The birth order of your child
7. Are there other adults at home other than parents who interact with the child on a daily basis?
   - ☐ Grandparents
   - ☐ Nanny
   - ☐ Others
   - ☐ None
8. Does your child go to daycare?
9. Which language does he/she speak in the school?
10. Mother's education

Language exposure and language use

11. Between *L1* and *L2*, how often do you use each language when speaking to your child?
    - ☐ 100% *L1* and 0% *L2*
    - ☐ 80% *L1* and 20% *L2*
    - ☐ 60% *L1* and 40% *L2*
    - ☐ Both languages equally
    - ☐ 40% *L1* and 60% *L2*
    - ☐ 20% *L1* and 80% *L2*

- ☐ 0% *L1* and 100% *L2*

12. Between *L1* and *L2*, how often does your spouse use each language when speaking to the child?

*Same options as above

13. Between *L1* and *L2*, how often does your child use each language when speaking to you?

*Same options as above

14. Between *L1* and *L2*, how often does your child use each language when speaking to your spouse?

*Same options as above

Language proficiency

15. How well do you think your child understands English compared to a monolingual *L1* child of the same age?

- ☐ 0 – Virtually no comprehension
- ☐ 1 – Limited comprehension: Only basic words and expressions
- ☐ 2 – Somewhat comprehension: Can understand simple comprehensions
- ☐ 3 – Good comprehension: Can understand extended comprehensions
- ☐ 4 – Very good comprehension: Can understand virtually any kind of conversations
- ☐ 5 – Native

16. How well do you think your child speaks English compared to a monolingual *L1* child of the same age?

*Same options as above

17. How well do you think your child understands German compared to a monolingual *L2* child of the same age?

*Same options as above

18. How well do you think your child speaks German compared to a monolingual *L2* child of the same age?

*Same options as above

19. How well do you think you speak your spouse' language?

*Same options as above

C. INFORMED CONSENT

The purpose of this study was to investigate the effects of being bilingual and growing up in a bilingual home environment on children's cognitive functioning. Through your participation, we hope to learn more about some of the characteristics of their minds that are shaped by bilingualism. You and your family members will be asked to provide a twenty minutes home recording and fill out a questionnaire regarding your bilingual experience. With your permission, your child will take a cognitive test with the researcher online for approximately twenty-five minutes.

Participation in the study must be voluntary. Cognitive testing will not have any negative psychological impact on your child and the test results, your recordings and completed questionnaires will be kept strictly confidential and will be evaluated by the researcher. All data are collected for scientific research purposes only. After the consent form is signed, you and your family members will have the right to withdraw from the study at any time.

We appreciate your participation. If you have any questions about the study, or need more information, you can contact us using the information below.

Tel:

E-mail:

After reading the above, I voluntarily participate in this study and give my consent for my child to participate in the study. I understand that I can withdraw from the study at any time. I agree that the information I provide may be used for scientific research purposes.

Name Surname Date Signature

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D. DEBRIEFING FORM

This study is designed to investigate how speaking two languages and exposure to a bilingual or multilingual home environment could have an effect on the cognitive functioning of young bilingual children.

For the past decade, researchers have debated the existence of the cognitive advantages of bilingualism. Recently, instead of comparing the cognitive abilities of the monolingual and bilingual groups, there has been increasing interest in how different dimensions of bilingual experience could associate with the performance of cognitive abilities within the bilingual group. Therefore, one of the main goals of this research proposal is to investigate how different facets of bilingualism including language proficiency, language use, and code-switching frequency may influence performance on cognitive functioning for young bilingual children. The other goal of the study is to examine the effect of environmental factors, namely parental factors on their young children's cognitive functioning. We are especially interested in knowing among the potential predictors of both parents and children, whether parental or children's factors would relatively contribute more to the variation of children's performance of cognitive abilities. To answer the above research questions, we firstly calculated language-switching frequency based on the audio recording of the family gathering, and language proficiency and usage based on the BiLEC questionnaire then examined their associations with children's cognitive control performance based on four of the cognitive control tasks.

We anticipate that preverbal children's language proficiency, language use, and code-switching frequency will not predict their cognitive functioning. We also expect that compared to children's language proficiency, language use, and code-switching frequency, the corresponding parental factors will act as relatively more dominant predictors in terms of children's cognitive control abilities. As for the possible difference in predicting ability between language proficiency, language use, and code-switching frequency, it will be the first exploration comparison analysis among those variables.

It is aimed that the preliminary data from this study will be obtained at the end of January 2023. These data will be utilized only for research purposes. For further information, about the study and its results, you can refer to the following names. We would like to thank you for participating in this study.

E. SAMPLE FOR THE CODE-SWITCHING CONVERSATION

M: Mother

F: Father

C: Child

“F	Gel, otur hadi, otur. Yapalım. Bak bunu buraya takıyoruz.
F	Buraya, tamam mI? Böyle. He-heh... Bu oldu mu?
C	Hayır, hayır... Bu olmuyor gibi.
F	Bunu nereye koyacağız?
C	Bu...
F	Buraya mı? Tamam. Bu nereye gidecek? Buraya mı? Bu buraya gelecek?
C	Hah, bu...
F	Tamam, bu buraya, tamam...
C	Hayır... bu gidecek. Bu gidecek baba.
F	Bu buraya mı geliyor? Tamam.
C	Baba hayır!
F	Bitti!
C	Hayır!
M	where is number two? Where is number two? Where is it?
C	Hayır!
M	Are you missing a piece Ela?
C	yeah.
M	Where is it? Check behind the door.
M	Go check behind the door.
C	*unclear*.
M	Is it behind the door?
C	No.
M	Check under the couch. Check under the couch.
M	Should be somewhere.
M	Did you find it?

C No.

C I don't know.

M Do you know where it is?

C I don't know.

M All right Ela, come here. Let's finish this.

C Gel?

M Gel.

M Where is that? ok that's missing

M Let's just continue ok?

M Where does this go?

C Right over here.

M All right. Where does this go?

C Over here.

M Over here?

C oh no, no no no. Find two.

M We need to find the two.

C Can I buy two? Can I buy two?

M All right.

C ok? *unclear*, ok?

M All right.

C ok?

M Put this over here.

C I found *something* mom. I found two.

M You found it. Where is it?

C I don't know.

C ...koydum.

F Koydun mu kızım?

C Evet.

M No it's missing.

C *unclear*.”

E. TURKISH SUMMARY / TÜRKÇE ÖZET

BÖLÜM 1

GİRİŞ

Dünya birbirine daha fazla bağlandıkça küresel iki dilli/çok dilli nüfus da artıyor. Bu arada araştırmacılar, bu benzersiz dil kapasitesi ile insanın bilişsel yetenekleri arasındaki potansiyel ilişkiye giderek daha fazla ilgi duymaya başlamaktadır. Bununla birlikte, son on yılda, iki dilli konuşanların tek dilli konuşanlara göre bilişsel bir avantaja sahip olup olmadığı günümüze kadar hararetli tartışmaların konusu olmuştur (Gunnerud ve diğerleri, 2020; Lowe ve diğerleri, 2021; van den Noort ve diğerleri, 2019). İki dillilik ve bilişin karmaşık ve tartışmalı doğası nedeniyle şüpheciler, "yürütme işlevinde iki dilliliğin avantajlarının ya mevcut olmadığını ya da çok spesifik ve belirsiz durumlarla sınırlı olduğunu" iddia etmektedir (Paap ve diğerleri, 2015).

Akademisyenler, "iki dillilik etkisi" hakkındaki tutarsız bulguların nedenlerinin 1) iki dillilik deneyiminden etkilenebilecek bilişsel sonuçları ölçmeye yönelik görevlerin geçerliliği; 2) yaş ve sosyoekonomik durum gibi belirli faktörlerin kafa karıştırıcı etkileri; 3) çocuklar ve yetişkinler arasındaki farklar; 4) ve en önemlisi, iki dilliliğin az gelişmiş tipolojisi (örneğin, yaşam boyu dengeli, daha sonra başlayan veya baskın olmayan dilin seyrek kullanımı) veya iki dillilik ile ilgili deneyimin ölçümünün çalışmalar arasında tutarlı bir şekilde rapor edilmemesi (Bialystok, 2017; De Cat ve diğerleri, 2016; Lowe ve diğerleri, 2021). Sonuç olarak araştırmacılar, iki dilli ve tek dilli gruplar arasındaki doldurulamayan bulguların potansiyel nedenini ele almak için yaygın olarak kullanılan gruplar arası yarı deneysel karşılaştırma tasarımı yerine teorik olarak motive edilen hipotezlere dayanan daha titiz bir yaklaşım çağrısında bulunmaktadır.

Fazla ilgi gören daha yeni yaklaşımlardan biri, bireysel iki dillilik farklılıklarını ve yürütücü işlevlerde iki dilliliğin avantajlarının varlığına (veya yokluğuna) potansiyel olarak katkıda bulunan altta yatan çalışma mekanizmalarını tespit etmektir (Bialystok ve Craik, 2022; Yang ve ark., 2016). Sonuç olarak, farklı iki dilli deneyimlerin etkisini

araştırarak tek dilli ve iki dilli gruplar arasındaki farklı bilişsel performansların kaynağını vurgulayan giderek artan bir literatür bulunmaktadır (Kang ve Lust, 2019; Kheder ve Kaan, 2021; Sulpizio ve diğerleri, 2020; Yow ve Li, 2015). Dil yeterliliği ve dil kullanımı, kişilerin kendi bildirdiği ve standartlaştırılmış ölçümlerden elde edilebilecek iki unsur olarak ortaya çıkmıştır. Ayrıca son yıllarda iki dillilik ve biliş ile ilgili yapılan çalışmalarda en sık incelenen özelliklerin bunlar olduğu belirtilmektedir (Luk , 2013; Surrain ve Luk , 2019).

İki dillilik deneyiminin yönlerinden biri olarak kod değiştirme, iki dilliliğin özelliklerinin şeffaf, tutarlı ve kapsamlı bir şekilde raporlanması açısından giderek artan bir ilgi bulunmaktadır (Kałamała ve diğerleri, 2023; Marian & Hayakawa, 2021). "İki dillilik avantajının" özünde, iki dilli kişilerin bilişsel kontrol çabasını yöneten izleme ve engelleme süreçlerini yaratan dil değiştirme davranışında yattığı ileri sürülmüştür (Costa ve ark., 2009). Bu araştırma doğrultusunda iki dilliliğin yukarıda belirtilen birden fazla boyutunu içeren çalışmalar sınırlıydı ve sonuçların oldukça tutarsız olduğu ortaya çıktı (Giguere ve diğerleri, 2022; Kheder ve Kaan, 2021). İki dilli deneyimin tüm kapsamını hesaba katmak için araştırmacılar, iki dilli deneyimin değişkenliğini dikkate alan analizlerin entegrasyonunu savunmaktadır (De Cat, 2018; Luk, 2015).

İki dillilik deneyimi ile bilişsel kontrol yeteneği arasındaki ilişkiyi tanımlayan araştırmalar neredeyse yalnızca okul çağındaki çocuklardan ve yetişkinlerden kanıt almaktadır. Yetersiz dil üretimine sahip, eş zamanlı genç iki dilli bireyler, iki dillilik ile bilişsel işlevsellik arasındaki ilişkiyi araştıran çalışmalarda nadiren hedef yaş grubu haline gelir (Verhagen ve ark., 2020). İki dilliliğin etkisinin, iki dilli konuşmacıların sık sık dil çatışmasını, dikkatlerini hedef dile odaklayarak, hedef olmayan dilin müdahalesini göz ardı ederek çözmelerinden kaynaklandığı genel olarak kabul edilmektedir (Green, 1998; Green ve Abutalebi, 2013). Çalışmaların çoğu sadece iki dilli bireyin dil yeterliliğinin, dil kullanımının ve kod değiştirme davranışının, dil üretiminde yeterli olduğu varsayımına dayanan bilişsel yeteneklerini nasıl etkilediğini araştırmıştır.

Bununla birlikte, tek dilli ve iki dilli bebekler ve küçük çocuklar arasında seçici dikkat, görsel alışkanlık, bilişsel esneklik ve genel yürütme işlevi açısından farklılıklar

defalarca keşfedilmiştir (Comishen ve diğerleri, 2019; Kovacs ve Mehler, 2009a, 2009b; Poulin-Dubois ve diğerleri, 2011; Singh, 2015; Verhagen ve diğerleri, 2020). Bu keşifler, iki dillilik etkisinin, doğrudan dil üretiminden kaynaklanmanın yanı sıra, iki dilin yalnızca maruz kalması ve işlenmesinden, yani iki dilli bağlam altında dilin anlaşılmasından da kaynaklanabileceğini göstermiştir (Dijkstra ve diğerleri, 1998).

Bu nedenle, genç yaş gruplarını hedefliyorsak ve bireysel iki dilli değişkenleri dikkate alıyorsak, eşzamanlı iki dilli çocuklar için iki dilli ortamı oluşturan ebeveyn faktörlerini de dahil etmek gerekmektedir. Şimdiye kadar çok az sayıda araştırma, ebeveyn dil yeterliliği ve ebeveyn dil kullanımı gibi ebeveyn faktörlerini iki dilli çocukların bilişsel performansının göstergesi olarak değerlendirmiştir (Verhagen ve diğerleri, 2020). Bildiğimiz kadarıyla, ebeveyn kodu değiştirme sıklığı gibi iki dilliliğin diğer yönleri hiçbir zaman ebeveyn değişkenleri açısından araştırılmamıştır.

Bu çalışma, araştırmacıların iki dilliliğin biliş üzerindeki etkilerini incelerken karşılaştıkları zorlukların yanı sıra yaş grubu açısından literatürdeki boşlukları ele almak üzere tasarlanmıştır. Tek dilli ve iki dilli konuşmacılar arasındaki popüler grup karşılaştırmasını kullanmak yerine, bu çalışmanın odak noktası, hem çocukların hem de ebeveynlerin iki dilli deneyimleriyle ilgili değişkenlerini, çocukların bilişsel kontrol yetenekleri üzerindeki iki dilli etkinin potansiyel göstergeleri olarak ele almaktır. Dil yeterliliği, dil kullanımı ve hem iki dilli çocukların hem de ebeveynlerinin kod değiştirme sıklığı da dahil olmak üzere iki dillilik deneyimiyle ilgili faktörlere ilişkin kademeli bir ölçüm uygulayarak iki dilliliğin etkisini ortadan kaldırmayı umuyoruz. Ayrıca, yeterli dil üretimi olmayan, iki dilli genç çocuklardan oluşan, nispeten az çalışılmış yaş grubuna odaklanmayı ve evlerindeki dil ortamlarını oluşturan ebeveyn faktörlerine dikkat etmeyi umuyoruz. Mevcut çalışmanın ana araştırma soruları aşağıdaki gibidir:

1. Hem küçük iki dilli çocukların hem de ebeveynlerinin dil yeterliliği, dil kullanımı ve kod değiştirme sıklığı dahil olmak üzere iki dilli deneyimin farklı yönleri, birbirleriyle ve çocukların bilişsel kontrol yetenekleriyle nasıl ilişkilendirilebilir?

2. Analizi bir adım daha ileriye taşımak için, iki dillilik deneyimiyle ilgili değişkenlerin çocukların bilişsel performansını yordayıp yordamadığını sorduk.

İki dilli deneyimle ilgili değişkenler arasında ve ayrıca çocukların bilişsel kontrol yetenekleri arasında karşılıklı ilişkiler olacağını tahmin ettik. Önceki literatüre dayanarak (Kang ve Lust, 2017; Kuzyk ve diğerleri, 2020), bu değişkenlerin biliş üzerindeki öngörüsüyle ilgili olarak; hem çocukların hem de ebeveynlerin dil yeterliliği ve dil kullanımının değişeceğini, ancak çocukların kod değiştirme sıklığının değişmeyeceğini ileri sürdük. Diğer taraftan ebeveynlerin kod değiştirme sıklığının olası etkisini de araştırdık çünkü bu konu daha önce hiç araştırılmamıştı.

Bölüm 2

Yöntem

Örneklem, ebeveynlerin ve çocukların her iki grubu da içeren 24 çok dilli aileden oluşmaktadır. Araştırmaya katılan çocuklar 3-4 yaş aralığındadır (on iki kız; $M_{yaş)}$ = 3;6; $SD_{yaşı}$ = 0,43; *Yaş Aralığı* = 2;7 – 4;2). Bu çalışmaya katılanlar, en az bir ebeveynin çocuklarıyla günlük olarak birden fazla dil konuştuğu ailelerden gelmektedir. Araştırmaya hem ebeveynler hem de çocuklar katılmıştır.

Tüm ebeveynler için farklı dil kullanım oranları farklılık gösterse de, tüm aileler evde her gün birden fazla dil konuşmaktadır. Ailede dil kullanımı araştırmacıların dil konfigürasyonuna göre Türkçe ve bir dil daha veya Türkçe ve İngilizce ve bir dil daha ile sınırlıdır. Hanede kullanılan diller İngilizce (*n* = 21), Türkçe (*n* = 15) ve şu dillerden biriydi: Çince (*n* = 6), Almanca (*n* = 3), Fransızca (*n* = 2), Arapça (*n* = 1), Rusça (*n* = 1), İspanyolca (*n* = 1), Kantonca (*n* = 1), Sırpça (*n* = 1), Bengalce (*n* = 1). İngilizce ve Türkçe olmak üzere birden fazla dil konuşan üç dilli aileler örnekleme dahil edilmemiştir. Ebeveynler arasındaki farklı dil kullanım oranı %100 (bir ebeveyn, bir dil) ile %20 (ebeveynler gün içinde zamanın %80'inde aynı dili konuşur) arasında değişmektedir.

Ailelerin yüzde 71'inin birden fazla çocuğu var ve yüzde 50'si diğer yetişkinlerin çocuklarıyla her gün etkileşim kurmaktadır. 24 aileden 21'i, test sırasında çocuklarını kreşe kaydettirmiş ve bu süre toplamda ortalama 14 ay olmuştur. Katılımcı ailelerin sosyoekonomik durumu orta ve üst düzeyde olup, ailelerin %88'inin gelir düzeyi aylık

20.000 TL'nin üzerindedir. Anne eğitim düzeylerine bakıldığında annelerin %96'sı lisans ve üzeri eğitime sahiptir.

Ailelerle sosyal medya ve kartopu örnekleme yoluyla temasa geçilmiş olup aileler çoğunlukla Türkiye'deki uluslararası ailelerden oluşmaktadır. Verilerin toplanmasından önce her aileden çevrimiçi toplantı yoluyla onam mektubu toplanmıştır. Bilişsel kontrol yetenekleri araştırmacıyla birlikte çevrimiçi görevlerden ikisi aracılığıyla test edilmiştir: Boyut Değiştirme Kartı Sıralama (DCCS) Görevi ve Görsel Arama Görevi. Ebeveynlerin ve çocukların dil yeterliliği, kullanımı ve diğer demografik bilgileri, İki Dilli Dil Deneyimi Hesaplayıcısının (BiLEC) (Unsworth, 2013) çevrimiçi anketinin basitleştirilmiş versiyonu aracılığıyla toplanmıştır. Son olarak ebeveynlere, ailelerinin (anne, baba ve çocuk dahil) günlük etkileşimlerinin 15 dakikalık bir ses kaydını kaydetmeleri istenmiştir. Çoğu aile, yemek zamanı veya oyun seansları sırasındaki konuşmalarını kaydetmiştir. Tüm görevlerin tamamlanmasının ardından aileye 150 Türk Lirası tutarında online Amazon hediye kartı, çocuklarına da görev performansına ilişkin sertifika verilmiştir.

Bölüm 3

Bulgular

İlk olarak çocukların ve ebeveynlerin kod değiştirme sıklığı, çocukların ve ebeveynlerinin dil yeterlilikleri, çocukların ve ebeveynlerinin dil kullanımı, bilişsel görev puanları ve yaşları arasındaki olası ilişkileri tespit etmek için korelasyon analizi yapılmıştır. Sonuçlar, çocukların kod değiştirme sıklığının çocukların dil kullanımıyla pozitif, yaş ve ebeveynlerin dil yeterliliğiyle ise negatif ilişkili olduğunu göstermiştir. Ebeveynlerin dil yeterliliği, ebeveynlerin dil kullanımıyla olumsuz yönde ilişkili bulunmuştur. Çocukların dil kullanımı, ebeveynlerin dil kullanımı ve çocukların dil yeterliliği ile pozitif yönde ilişkili olmuştur. Son olarak, çocukların bilişsel görev performansı yaşla güçlü bir şekilde ilişkili ancak hem çocuklardan hem de ebeveynlerden gelen iki dillilik deneyimiyle ilgili değişkenlerin herhangi biriyle ilişkisiz olduğu görülmüştür.

Daha sonra ana sorumuz olan ebeveynlerin ve çocukların çift dillilik deneyimine bağlı değişkenlerinin çocukların bilişsel kontrol yeteneklerini yordayıp yordamadığına bakılmıştır. Toplamda beş hiyerarşik regresyon modeli gerçekleştirildi. Her model iki görevin birleşik puanıyla üç adımdan oluşuyordu. Her modelin ilk adımı yaşı içeriyordu. Beş modelin ikinci adımları sırasıyla çocukların ve ebeveynlerin dil yeterliliğini, çocukların ve ebeveynlerinin dil kullanımını, çocukların dil yeterliliğini, çocukların dil kullanımını ve çocukların kod değiştirme sıklığını içeriyordu. Üçüncü adım, ilk iki model için hem çocukların hem de ebeveynlerin kod değiştirme sıklığını ve son üç model için ebeveyn faktörlerini içeriyordu. Beş modelin tamamında model her adımda anlamlıydı. Tüm modellerde her adımda girilen değişken kombinasyonları, sonuç değişkenlerindeki daha fazla varyasyonu açıkladı. Tüm adımlarda tek anlamlı değişken test sırasındaki yaştı.

4. Bölüm

Tartışma

Bu çalışmaya, "iki dillilik etkisinin" altında yatan mekanizmayı belirlemek için dil yeterliliği, dil kullanımı ve kod değiştirme sıklığı gibi iki dillilik deneyimiyle ilgili çeşitli faktörler dahil edilmiştir. Spesifik olarak, iki dilli küçük çocuklardan ve ebeveynlerinden kaynaklanan faktörler, yeterli dil üretimi olmayan iki dilli konuşmacılar üzerindeki potansiyel bilişsel etkileri incelerken çevresel faktörlerin de (iki dilliliğin ebeveyn göstergeleri) dikkate alınması gerektiği varsayımıyla araştırılmıştır. İki dilli küçük çocukların ve ebeveynlerin dil yeterliliği, dil kullanımı ve kod değiştirme sıklığı da dahil olmak üzere iki dillilik. Daha sonra yukarıda belirtilen faktörlerin çocukların bilişsel kontrol yeteneklerini yordayıp yordamadığını analiz ettik. Bildiğimiz kadarıyla bu çalışma, iki dillilik boyutlarının üçünü de içeren, çevresel faktörleri dikkate alan ve doğal gözlem yoluyla kod değiştirme sıklığını hesaplayan ilk çalışmadır. Genel olarak, sonuçlar iki dillilik deneyimiyle ilgili değişkenlerin yalnızca çocuklar veya ebeveynler arasında değil (örneğin, çocukların dil yeterliliği dil kullanımıyla ilişkili) değil aynı zamanda çocuklar ve ebeveynler arasında da (örneğin çocukların kod değiştirme sıklığı ebeveynlerinin dil yeterliliğiyle ilişkili) ilişkili olduğunu gösterdi. Ancak yaşla ilgili değişkenler (iki dillilik

deneyimiyle değil) çocukların bilişsel kontrol yeteneklerini güçlü bir şekilde öngörmektedir.

İki dillilik deneyimiyle ilgili değişkenler arasındaki ilişkiler

İki dillilik deneyiminin pragmatik bir temsilini koruma ihtiyacı nedeniyle, mevcut veri tabanından veya özel çalışma tasarımından çıkarılan iki dillilik ile ilgili faktörlerin analizde birbirleriyle ilişkilendirilmesine izin verilmektedir. Bir ağ modelinin, karmaşık bir ilişkiler modeli oluşturmak için diğer faktörlerle birlikte dil yeterliliği, dil kullanımı ve kod değiştirme sıklığı gibi iki dilliliğin en merkezi göstergelerine daha uygulanabilir olacağı savunulmaktadır (Kałamała ve diğerleri, 2023).

Bu faktörlerin yapılarına uygun olarak, incelenen değişkenler arasında çeşitli korelasyonlar keşfedilmiştir. İlk olarak, çocuklar ana dillerini ne kadar dengeli kullanırsa, çocuklar o kadar küçük olur ve ebeveynlerinin ikinci ana dili ne kadar az yetkin olursa, çocuklar her gün bir dilden diğerine o kadar sık geçiş yapar. Çocukların yaşı ile kod değiştirme sıklığı arasındaki negatif ilişki önceki çalışmayla tutarlıdır (Kuzyk ve diğerleri, 2020), çocukların iki dile dengeli hakim olmak yerine yeterlik eksikliği nedeniyle diller arasında geçiş yaptığını açıklamıştır (Ribot ve Hoff, 2014). Baskın olmayan dille ifade ederken dil boşluğunu doldurmak için egemen dillerinden sözcük veya cümleleri "ödünç almaları" gerekir; bu nedenle, daha zayıf olan dillerine daha iyi hakim olduklarında dil değiştirme davranışı azalır.

Ayrıca, ebeveynlerin ikinci ev dil yeterliliği ile çocukların kod değiştirme sıklığı arasındaki negatif korelasyon, bu çalışmaya katılan ailelerin bağlamından kaynaklanıyor olabilir. Ebeveynlerin farklı anadilleri konuştuğu ailelerde, çiftler arasında birbirlerinin dilini akıcı olarak konuşamamanın, çocukların ebeveynleriyle farklı dillerde konuşmaya alıştığı doğal bir "tek ebeveyn, tek dil" konuşma ortamı yarattığını gözlemledik. Bu korelasyon, önceki çalışmalardan birindeki keşfe güçlü bir destek sağladı; iki dilli çocukların, ebeveynlerinden biri veya ikisi daha zayıf olan ana dillerinde, ebeveynleri ile karşılaştırıldığında düşük düzeyde dil ustalığı gösterdiğinde seçici dikkat görevinde daha iyi performans göstermektedir. Önceki araştırmacılar (Verhagen ve diğerleri, 2019) tarafından; ebeveynlerin kendi ana dillerindeki dil yeterliliğinin, iki dilli küçük çocukların dil değişimi için bir aracı görevi görebileceğini

ve bunun da çocukların bilişsel yeteneklerini geliştiren daha zayıf bir faktör olduğu öne sürülmüştür. Bu varsayım mevcut bulgularımız tarafından da desteklenmektedir.

Bir başka ilginç bulgu ise, çocukların ana dillerini dengeli bir şekilde kullanıp kullanmamalarının, çocukların bu dillere eşit hakimiyete sahip olup olmadıkları ve ebeveynlerin "tek ebeveyn, tek dil" politikasını uygulayıp uygulamamalarıyla olumlu yönde ilişkili olduğunu gösterdi. Öte yandan, ebeveynlerin dilleri birbirinden farklı kullanıp kullanmadıkları, ikinci ana dil yeterliliklerinin yanı sıra çocukların her iki ana dili de eşit şekilde kullanıp kullanmadıklarına göre belirlenmektedir. Özellikle çocuklar için, iki dilin yeterliliği ne kadar dengeliyse, onları o kadar dengeli kullanacaklardır. Bunun tersine, ikinci ana dillerinde daha az yetkinliğe sahip olan ebeveynler için, iki ana dil evde dengeli bir şekilde kullanılacaktır. Bu bulgular, araştırma sırasında gözlemlediğimiz gibi, hem çocukların hem de ebeveynlerinin dil kullanım alışkanlıklarının, ustalık düzeylerine ve muhataplarının dil kullanım alışkanlıklarına göre belirlendiğini ortaya koymuştur. Hem çocuklar hem de ebeveynler dil geçişini başlatmıştır; her iki durumda da muhataplar, her etkileşim sırasında dil kullanımlarında birbirleriyle tutarlıydı.

İki dillilik deneyimine ilişkin değişkenlerin çocukların bilişsel kontrol yeteneklerine etkisi

Ayrıca, iki dilli deneyimle ilgili faktörlerin (özellikle kod değiştirme sıklığının) çocukların bilişsel kontrol yeteneğini etkileyip etkilemediğini ve ebeveyn veya çocuk faktörlerinin, iki dilli küçük çocukların bilişsel kontrol yeteneğindeki çeşitliliği potansiyel olarak açıklayıp açıklayamayacağını da araştırdık. Sonuçlarımız yalnızca çocukların yaşının bilişsel performanslarının güçlü bir belirleyicisi olduğunu gösterdi. Kod değiştirme sıklığının yanı sıra ebeveyn faktörlerinin bireysel etkilerini incelemek için hiyerarşik regresyon kullanarak odağımızı daraltmayı başardık. Ancak yine de kayda değer bir sonuç bulamadık. Başka bir deyişle, çevresel faktörlerin veya daha ince taneli kod değiştirme faktörünün, çocuklara ilişkin faktörlere veya diğer iki dilli deneyimle ilgili değişkenlere kıyasla daha güçlü belirleyiciler olarak hareket edebileceği yönündeki varsayımlarımız desteklenmedi.

Örneklem büyüklüğünün küçük olması, çocukların yaşı dışında herhangi bir etkinin bulunmamasının nedenlerinden biri olabilir. Türkiye'nin dilsel homojenlik açısından

dil özelliğinden dolayı, hedef katılımcı grubumuzu Türkiye'de uluslararası toplum içerisinde oluşturduk ve bu da kaçınılmaz olarak çalışmamızın potansiyel örneklem büyüklüğünü etkiledi. Üstelik çalışma, ses ve farklı iki dilli deneyimler gibi alanda önde gelen araştırmacıların (Bialystok & Shorbagi, 2021; Luk & Grundy, 2022) savunduğu kafa karıştırıcı faktörlerden kaçınmak için dikkatlice tasarlanmış olsa da, hala araştırma olanakları mevcuttur. İki dilli etki araştırmalarının çoğu, sözel olmayan zeka ölçümlerini nadiren rapor etse de, bazı çalışmalar, katılımcıları sözel olmayan uzamsal muhakeme görevleriyle değerlendirerek bu faktörü kontrol etmiştir (Bialystok ve Shorbagi, 2021; Treffers-Daller ve diğerleri, 2020). Ek olarak, farklı dilsel ve kültürel bağlamlara sahip katılımcıları işe almak yaygın, hatta teşvik edilen bir uygulama gibi görünse de (Verhagen ve diğerleri, 2020; De Cat ve diğerleri, 2018), diller arası ve kültürler arası etkiler henüz ortaya çıkmamıştır. Bu araştırma kapsamında bu etki de sistematik olarak incelenmiştir. Bu potansiyel etkiler hem ebeveynlerin hem de çocukların iki dilli deneyimlerini etkileyebilir ve bu da potansiyel olarak çocukların bilişsel performansını etkileyebilmektedir.

Doğal gözleme dayanan iki dilli deneyimi ölçme yöntemlerimizin katılımcılarımızın gerçek dil uygulamalarını doğru şekilde yansıtmaması da mümkündür. Önceki literatürde, iki dilli konuşmacıların günlük yaşamda diller arasındaki geçişini belgelemek için laboratuvar dışında doğal gözlem uygulanması tavsiye edilmişti (Kuzyk ve diğerleri, 2020). Ancak mevcut çalışmada ses kaydı, uzun bir sürenin gerçek zamanlı belgelenmesi yerine yalnızca kod değiştirme senaryosunun anlık görüntüsünü yakalamayı başardı. Spesifik olarak, önceden belirlenen zaman diliminin sınırlı olması nedeniyle, kayıttan önce ebeveynlere konuşmanın doğal ve spontane olması gerektiği konusunda bilgi verilmiş olmasına rağmen, bazı ebeveynlerin konu oluşturmaları ve dilleri bilinçli olarak dikkatli bir şekilde seçmeleri konusunda baskı altında oldukları gözlemlenmiştir. Bu nedenle, mevcut çalışmadaki doğal gözlem yöntemi, anket yoluyla kod değiştirme sıklığının ölçülmesine kıyasla keşifsel bir adım olsa da, kod değiştirme davranışının geçerli bir göstergesi olarak kabul edilmek için hala yeterli olmayabilir. Şimdiye kadar çocukların ve ebeveynlerin kod değiştirme davranışına ilişkin ebeveynlerin tahminini araştıran yalnızca birkaç kod değiştirme ölçeği bulunmaktadır (Kremin ve diğerleri, 2021). Bununla birlikte ölçek puanı, ebeveynlerin kod değiştirme sıklığı açısından varyansın yalnızca %14'ünü

açıklamaktadır. Sonuç olarak, çocukların kelime dağarcığı veya morfoloji ve sözdiziminin belirli yönleri hakkındaki ebeveyn raporlarının güvenilirliği ve geçerliliğiyle karşılaştırıldığında (Fenson ve diğerleri, 1994), hem çocuklar hem de ebeveynler için kod değiştirme tahminine yönelik ölçeklerin geliştirilmesi ve daha fazla ayrıntılandırma gerekmektedir.

Dolayısıyla çalışmamızın sonuçları iki dillilik etkisinin varlığını desteklememektedir. Bir meta-analiz, iki dillilik avantajının genel etki büyüklüğünün marjinal olduğunu öne sürmektedir (Gunnerud ve diğerleri, 2020). Ayrıca birden fazla dil konuşmanın bilişsel performans üzerindeki olası etkisinin, eğer varsa, tespit edilmesinin zor olacağı ve ayrıca belirli durumlarla sınırlı olacağı da rapor edilmiştir (Lowe vd., 2021; Paap vd., 2015). Bulgularımız, iki dilliliğin bilişsel kontrol yeteneğini etkilemediğine dair daha fazla kanıt sağlayabilir. Bununla birlikte, bunun nedeni bilişsel kontrol becerilerini geliştirmenin sürekli mücadele gerektirmesi olabilir (Diamond ve Ling, 2016). İki dilli bireylerin bilişi üzerinde potansiyel etkiye yol açmaktadır. Bununla birlikte, konuşma kalıbı olgunlaştığında ve artık yukarıdan aşağıya bilişsel kontrol gerektirmediğinde, aileler içindeki dil değişimi otomatik hale gelebilir. Durum böyleyse, iki dilli küçük çocuklar ve aileleri üzerinde, çocukların dil gelişimini, özellikle de ortaya çıkan kod değiştirme modelini, daha alışılmış etkileşimli modele kadar, tanımlama umuduyla belgelemek için boylamsal bir çalışma tasarlamak faydalı olacaktır. Potansiyel bilişsel etkiye yol açabilecek “özel ve belirlenmemiş koşullar”.

Ayrıca bu çalışma, iki dilliliğin birden fazla boyutunu dahil ederek, iki dilli konuşmacıların heterojen özelliklerini dikkate alan iki dillilik etkisine ilişkin sınırlı literatüre katkıda bulunmuştur. Bir bireyin iki dilli deneyiminin özelliklerini çözmeye ve hangi özelliklerin bilişsel kontrol yeteneğini geliştirmeye potansiyel olarak katkıda bulunabileceğini araştırarak altta yatan mekanizmayı ortaya çıkarmaya yönelik birincil temele katkıda bulundu. Bu alandaki dikkatin, tek dilli ve iki dilli gruplar arasındaki grup karşılaştırmasından, iki dilliliğin daha ayrıntılı yönlerinin iki dilliliğin etkisini tahmin edip edemeyeceğini araştırmaya kayması, alandaki öncü araştırmacılar tarafından savunuldu (Bialystock ve Craik, 2022). İki dillilik bileşimini belirleyerek ve bu göstergeleri gerileme yoluyla bilişsel yeteneklerle ilişkilendirerek, altta yatan çeşitli potansiyel mekanizmaları daha derinlemesine görebiliriz. Önemsiz olmasına

rağmen, mevcut çalışmanın sonucu, halen büyümekte olan bu araştırma dizisine daha fazla referans katacaktır.

Ayrıca çalışmamız, dil üretimi sınırlı olan iki dilli gençlerin çevresel faktörlerini içeren çok az çalışmadan biridir. Sınırlı dil üretimine sahip iki dilli grupların, ebeveyn faktörlerini de içeren grup içi araştırma tasarımı kullanarak nasıl araştırılacağına dair bir çözüm önermektedir. Bu çalışmada iki dillilik ile ilgili faktörler ile bilişsel performans arasındaki bağlantıları tespit edememiş olsak da, yalnızca dil üretimini olası göstergeler olarak ele almak yerine daha genç yaş grubunu ve maruz kaldıkları dil ortamını hedeflemek tamamlayıcı bir bakış açısıdır.

Sonuç

Bu çalışmada, iki dilli küçük çocuklarda ve ebeveynlerinde dil yeterliliğini, kullanımını ve kod değiştirmeyi araştırarak "iki dillilik etkisini" araştırdık. Bu faktörler arasında korelasyon bulmamıza rağmen, çocukların bilişsel kontrol yeteneklerini kendilerinin veya ebeveynlerinin iki dilli deneyiminden ziyade yaşının güçlü bir şekilde öngördüğünü keşfettik. Sonuçlarımız açık bir iki dillilik avantajı göstermese de, iki dillilik ile ilgili yönler arasındaki karmaşık ilişkileri vurguladı ve iki dillilik ve biliş ile ilgili araştırmalar doğrultusunda iki dilli genç konuşmacılar için çevresel faktörlerin dikkate alınması gerektiğini önerdi. Çalışmamız, iki dilliliğin farklı yaş grupları için biliş üzerindeki etkisinin gelişen anlayışına katkıda bulunmaktadır. İki dillilik etkilerinin ortaya çıkabileceği koşulları ortaya çıkarmak için ayrıntılı ve boylamsal araştırmalara duyulan ihtiyacı vurguluyor.

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