Multilingualism Across the Lifespan:

Exploring Social and Cognitive Factors in Language Switching and Use

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Abstract:

This dissertation investigates how environmental and cognitive factors can influence language use and language switching in bilinguals with different degrees of language knowledge and at different stages in the lifespan. By using different methodologies and theoretical approaches, this dissertation explores to what extent language use in bilinguals in shaped by the multilingual environment in the early years, such as language ideologies and practices of the caregivers, speakers' cognition, and the degree of language experience.

The dissertation consists of three studies, each disseminated through a paper**.** Study I addresses the role of language ideologies in the language practices and policies of multilingual families in Norway, and how the Covid-19 pandemic impacted the language exposure and use of multilingual children. Thus, this paper illustrates that significant societal changes can have an impact on the daily communication of multilingual speakers.

Study II tackles the question of whether domain-general executive control is required in bilingual children's language control. This is an understudied question in the field, and this study is one of the few to explore this question by using a lab-controlled language switching task and cognitive tests measuring executive functions. Furthermore, the study explores whether language practices between parents and children are associated with language control and executive control.

In Study III, the question of whether bilingual language control relies on domain-general executive functions is further studied in an adult population with different degrees of language experience. This study is one of the first to test experimentally one aspect of the skill learning hypothesis, that is, the role of prolonged bilingual experience in the relationship between language switching and executive control. This hypothesis could offer explanations for the inconsistency of results in regard to the language switching and executive control associations.

The results presented in this dissertation show that societal factors can impact the language dynamics of multilingual families and offer opportunities for language use. Furthermore, the findings on the relationship between bilingual language control and executive functions challenge the currently adopted domain-generality theories, but could be explained by the skill learning account. In sum, this dissertation shows how both environmental and cognitive factors shape bilingual language processing and use at different stages in the speakers' lifespan.

Sammendrag

Denne avhandlingen undersøker hvordan miljømessige og kognitive faktorer kan påvirke språkbruk og språkbytte hos flerspråklige med varierende språkkunnskap, på ulike stadier i livsløpet. Ved å kombinere flere ulike metodologiske og teoretiske tilnærminger viser avhandlingen at språkbruk hos flerspråklige påvirkes av det flerspråklige miljøet i de første leveårene – slik som omsorgspersonenes språkideologier og praksiser – og av språkbrukernes kognisjon og erfaringer med språkene.

Avhandlingen består av tre delstudier, som har munnet ut i hver sin artikkel. Studie I tar for seg språkideologiers rolle i flerspråklige familiers språkpraksis og språkpolitikk i Norge, og hvordan covid-19-pandemien påvirket flerspråklige barns språkeksponering og språkbruk. Artikkelen illustrerer at betydelige samfunnsendringer kan ha innvirkning på flerspråkliges daglige kommunikasjon.

Studie II tar for seg spørsmålet om hvorvidt domenegenerell eksekutiv kontroll er nødvendig for flerspråklige barns kontroll over språkene sine. Dette er et understudert spørsmål, og denne studien er en av få som angriper spørsmålet gjennom en laboratoriekontrollert språkvekslingsoppgave og kognitive tester som måler eksekutive funksjoner. Videre undersøker studien om språkpraksiser mellom foreldre og barn henger sammen med språkkontroll og eksekutiv kontroll.

I studie III er spørsmålet om språkkontrollen hos voksne flerspråklige med varierende språkerfaringer er avhengig av domenegenerelle eksekutive funksjoner. Studien tester ferdighetslæringshypotesen eksperimentelt, som den første i sitt slag, for å kaste lys over inkonsistente resultater rundt sammenhenger mellom språkbytte og eksekutiv kontroll.

Resultatene som presenteres i denne avhandlingen, viser at samfunnsmessige faktorer kan påvirke språkdynamikken i flerspråklige familier og gi muligheter for språkbruk. Funnene av sammenhenger mellom flerspråklig språkkontroll og eksekutive funksjoner utfordrer rådende teorier som forutsetter domene-generalitet, men stemmer overens med en tilnærming som tar utgangspunkt i ferdighetslæring. Alt i alt viser denne avhandlingen at både miljømessige og kognitive faktorer påvirker flerspråklig språkprosessering og språkbruk på ulike stadier i talernes livsløp.

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El amor es gritarse a kilómetros de distancia.

This dissertation is the product of more than three years of hard work, discipline, and perseverance. While the PhD experience is a lonely one, it is not one that can be done alone. I wish to thank the many souls who have held my hand during this arduous process.

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Por último, a los ausentes. A los que debieron estar, pero (en el camino) se perdieron.

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Article I

García González, E., Liu, L., & Lanza, E. (2023). Language in multilingual families during the COVID-19 pandemic in Norway: a survey of challenges and opportunities. *Multilingua*. https://doi.org/10.1515/multi-2023-0011

Article II

García González, E., Jylkkä, J., & Lehtonen, M. Ready, Steady, Switch! Limited evidence for the role of executive functions in bilingual language control in children. *Unpublished manuscript*

Article III

García González, E., Lahdenranta, S., & Lehtonen, M. Are executive functions engaged in language switching? The role of language proficiency. *Unpublished manuscript*

Abbreviations

ACH	Adaptive Control Hypothesis
BiLEC	Bilingual Language Experience Calculator
CLT	Cross-linguistic Lexical Task
CN	Cued naming (task)
CS	Color Shape (task)
DCCS	Dimensional Change Card Sort (task)
EF(s)	Executive Functions
EFA	Exploratory Factor Analysis
HL	Heritage/Home Language
IC	Inhibitory Control
FLP	Family Language Policy
L2	Second Language
NSCRT	Nonverbal Stroop Card Sorting Test
OPOL	One-Parent-One-Language
OL	Other Language
SES	Socio-economic status

Part I

Synopsis

It would be years before I learned.

– Vivian Gornick –

Fierce Attachments

1. Introduction

Most humans across the globe are able to communicate in one or more languages, dialects, or registers. Some people grow up exposed to more than one language from birth, others come in contact with a second language later in childhood, and other people learn a second language as adults. Sometimes, all these circumstances might co-occur in the life of a single speaker, and other times a speaker might experience a reduction in exposure and use of a language that was more present in their past. For some people, acquiring a language in childhood might help them maintain it across their lives, and others may feel more connected to languages they learned as adults, and in which they were able to undergo life experiences that shaped them. Multilingualism comes in different shapes and forms, it is an individual experience, and it is also a dynamic one. Even though multilingualism is a rather frequent phenomenon, the interest in studying multilingualism in relation to cognition and its potentially positive effects has increased significantly in the last twenty years (e.g., Bialystok et al., 2012; Bialystok, 2017).

The concept of cognition is used to refer to a wide range of mental processes that include perception, learning, storage in and retrieving of information from memory, among other things. However, in addition to our internal worlds, an important aspect to consider when we talk about cognition is that it relates to how the human mind interacts with the environment. While cognitive development is a natural internal process that starts from the time of birth, our cognition is shaped by the effect of long-term as well as everyday life experiences. Cognitive development is thus an ever-changing process, although certain life periods stand out as developmental milestones. For instance, the early years of childhood are known to be periods of great cognitive development. Some areas of the brain, like the pre-frontal cortex, undergo great developmental changes in the first five years of life, although it continues to develop throughout adolescence and into young adulthood (Best et al., 2009; Best & Miller, 2010). The pre-frontal cortex is an area of the brain that is highly associated with executive functions (EFs). EFs are broadly understood as high-level behavioral goal-oriented processes that are heavily connected to decision-making, inhibitory control, task-shifting, and working memory. In everyday situations, EFs support individuals' self-control, such as impulsivity, which is why some literature on ADHD in preschool children points at deviations in EFs compared to typically developing children (Isquith et al., 2004). Because of the important role that they have in everyday behaviors, researchers have been interested in understanding what role EFs, if any, might have in language use. In the domain of language,

research has addressed, e.g., the role that these domain-general EFs may have in bilingual language use (e.g., Green & Abutalebi, 2013), in language learning (Kapa & Colombo, 2014), and language recovery after brain damage (e.g., Simic et al., 2020).

A significant portion of psycholinguistic research in the last twenty years has focused on how multilinguals might, in fact, be different from monolinguals. The basis of this exploration has centered around the fundamental question as to whether inherent bilingual behaviors, such as the active alternation of languages, language switching, may impact bilingual speakers' cognition in a way that it could not affect that of monolinguals. The grounds for this assumption will be further developed in this dissertation, but the key aspect of the research aiming to explore cognitive differences between monolinguals and bilinguals relates to whether bilingual behaviors could have a training effect on general cognition.

The question about differences between monolinguals and bi- or multilinguals has not been exclusive to the fields of cognitive science or psycholinguistics. The fields of sociolinguistics, ethnography and anthropology – to name a few – have also inquired about how attitudes and policies might shape communities and even individuals' self-perception and identity, as well as their language. These factors are not static either, as they fluctuate according to historical, political and societal changes, and are ultimately as important as cognition to the understanding of the multilingual experience.

This dissertation aims to study how speakers' individual cognitive characteristics and external, environmental factors interact and ultimately affect multilingual language processing and use across the lifespan. In the following sections, I delve into how language identities, practices, and policies at the family level influence language use in multilingual children, as well as how unexpected changes in society, such as the Covid-19 pandemic, can influence them. I also address to what extent multilingual children's language processing, and specifically language control, is associated with general, non-verbal cognitive processing, and whether this relationship relates to families' linguistic practices. Lastly, I explore whether the potential association between language control and domain-general executive control remains unchanged throughout the lifespan, or whether prolonged bilingual experience could affect this relationship.

1.2 A word on terminology

Language shapes our thoughts. You cannot answer a question that you cannot ask, and you cannot ask a question that you have no words for.

– Judea Pearl & Dana Mackenzie –

The Book of Why: The New Science of Cause and Effect

This dissertation uses specific terminology to define theoretical and empirical constructs of language and cognition. The field of linguistic research overlaps with a multitude of fields from psychology and cognitive science to sociology, education, and ethnography to name a few. As such, certain concepts might be referred to in different ways by different expert researchers. This is particularly common in the study of language where diverse theoretical approaches meet society's perspectives and ideologies. In order to facilitate the reader's understanding of the topics discussed in this dissertation, I will briefly define and aim to clarify the most important terminology that will be used.

This dissertation uses the terms executive control to refer to speakers' general cognitive control mechanisms. Specifically, I refer to these terms in relation to executive functions, which are relevant for numerous everyday tasks. According to Miyake's (2000) "unity and diversity" approach, there is a degree of overlap between executive functions, but there are clear differences, too, in how they are used for different tasks The main executive functions are inhibitory control, working memory updating, and cognitive flexibility. Whether this overall executive control is associated with language control, or speakers' ability to select and switch to the desired language, is a question we address in detail in Studies II and III.

The sample populations in this dissertation are children and adults who are users of two or more languages. I refer to these individuals as "bilinguals" and "multilinguals." Whether one should choose one term or the other is an ongoing discussion in the field of multilingualism (Dewaele & Stavans, 2014; Dewaele, 2015). Prior & Hell (2021) use the term bilingual to refer to any person who uses more than one language on a daily basis throughout their life, while de Houwer (2022) extends the term bilingual to any person who uses two or more languages. Here, I use "bilingualism" and "multilingualism" interchangeably. In Study I, we included families with a

diverse constellation of linguistic backgrounds, some of which used up to five languages in the household. When presenting and discussing this study, I mostly use the term multilingual. Study II and III, however, are framed within a theoretical cognitive framework that largely uses the notion of bilingualism, and thus this is the preferred term to discuss such studies. While the participants in these two studies were knowledgeable in other languages, specific language pairs were studied (i.e., Finnish-Swedish and Norwegian-Spanish). For the children in Study II, these were also the languages the participants used most frequently on a daily basis, whereas the participants in Study III who had learned Swedish later in life also knew other languages, typically English.

The notion of early versus late bilingualism is worth discussing. The field does not refer to notions of early and late bilingualism, that is whether a bilingual speaker has acquired one of the languages early or late in life is, in a systematic manner. In fact, Kremin & Byers-Heinlein (2021) provide examples of how different studies use the same labels to refer to very different characteristics. For instance, Tao et al. (2011) define their sample as "early bilingual" if they acquired both languages before age 6, whereas Baker & Trofimovich (2005) used the same term to refer to speakers who learned both languages before the age of 13. While there might be well-reasoned arguments for these methodological decisions, these are often not expressed explicitly. Despite the confusing terminology, there is a certain consensus in the field that significant cognitive and linguistic development takes place during the ages of 0-6 (Best et al., 2009; Best & Miller 2010), and it is thus used as a threshold for early bilingual acquisition. In this dissertation, I roughly use that threshold following the example of previous studies (e.g., Tao et al., 2011; van Dijk et al., 2022). An additional aspect to consider is the age at which children enter the school system, which usually coincides with the peak of these formative years. This is an important factor to consider when studying bilingualism, as children's schooling in the society language can inevitably favor the exposure and use of such language in comparison to the home language (de Houwer, 2022; Kupisch & Rothman, 2018). In Norway, children enter the school system at age 6, and in Finland, at age 7, and the latter was used as a threshold for early bilingualism in the inclusion criteria in Studies II and III. Nevertheless, as Section 3 (Method) will show, the participants in those studies had acquired both languages much earlier. This was of particular importance for Study II as the sample was child bilinguals, and sufficient length of exposure to the languages was required for

them to hold a conversation and ultimately be included in the study. For Study III, adults who had acquired Swedish after age 7 were considered late-learners.

Lastly, this dissertation uses the term "proficiency" to refer to participants' knowledge of the languages of interest, which was measured with different language assessments that are described in the Method section. While I acknowledge this term may not sufficiently reflect a speaker's language use and ability to communicate effectively in a language – which might also change across the lifespan – I use this term as an index of language use and language dominance in multilingual speakers to better understand how these characteristics may explain the intertwined relationship between language and cognition.

2. Theoretical framework and previous research on multilingualism

2.1 Language ideologies, language practices, and language management in multilingual families

The number of transnational families raising multilingual children has increased significantly over the last few years (Lanza & Lexander, 2019). However, their circumstances, experiences, and family language dynamics constitute a considerable amount of diversity and heterogeneity. In addition, the political, demographic, and socio-cultural environment around children growing up in multicultural, multilingual families creates a very distinct scenario depending on the country, its linguistic diversity, and the linguistic ideologies of the community and, ultimately, influences multilingual development (King & Curd-Christiansen, 2022)

Adopting an integrative approach, the field of Family Language Policy (FLP) combines the study of the social-cultural environment outside the home as well as parents' ideologies and the decision-making strategies that have an impact on children's linguistic development, thus offering a unique perspective on language acquisition and language policy. These factors, in addition to formal education, have important ramifications for the use of, and relation to, the home and minority languages. The factors that influence the multilingual experience are varied from internal cognitive developmental trajectories (Hollebeke et al., 2020) to the parent's or caregiver's language ideologies and practices, which are also shaped by society's view of multilingualism (King & Curd-Christiansen, 2022).

FLP encompasses the ways in which families and communities manage language use and language development within their social contexts. Following Spolsky's (2004) tripartite model on language policy, FLP can largely be divided into three key components: language beliefs, language practices, and language management. *Language beliefs* refer to the attitudes and ideologies surrounding a language or languages within a family or community. These beliefs, which can be positive or negative, can shape language use, language maintenance, and language practices. For example, a family that believes in the importance of maintaining their heritage language may actively encourage their children to use that language at home and provide opportunities for language learning (Hollebeke, 2020). However, language beliefs can impact multilingual speakers negatively. Sevinç and Dewaele (2018) showed that multilingual speakers with immigrant backgrounds may experience language anxiety, which can affect their ability to maintain and develop their heritage language skills over time. Ultimately, language anxiety was a significant predictor of language maintenance among multilingual speakers. Nevertheless, language beliefs are not static and can change over time across generations. For instance, Sevinç (2016) found that linguistic identity tends to decrease across generations of immigrants. This means that first-generation immigrants are more likely to feel a strong connection to their heritage language and culture, whereas second and third-generation immigrants may feel less connected to these aspects of their identity. The socio-economic status (SES) of families can influence positive or negative attitudes towards multilingualism. Families who foster more positive attitudes towards multilingualism might be more likely to promote language use and maintenance, as well as support the development of literacy skills in the home language (Kang, 2015). Ultimately, understanding the language beliefs and attitudes of families and communities is an important aspect of developing effective language policies and promoting language maintenance.

Language practices encompass the decisions that parents and caretakers make about language use in the family environment. While families might not have a unique approach to language use at home, some parents choose to follow a One-Parent-One-Language (OPOL) strategy (Ronjat, 1913), or a more relaxed approach to switching and mixing languages in their daily communication (Lanza, 2004). In practice, however, families fluctuate across a spectrum of these two, which might change and evolve with time or depending on the environment the family is in. It has been argued

that language practices could be construed as policy, however, research that follows parent-child interactions shows that these practices are rather flexible and not imposed on the child, but rather change over time in association to the parents' discourse strategies and children's response to them (Lanza, 2004).

Lastly, *language management*, or planning, as proposed by Spolsky (2003), refers to the effect that actions, whether from groups or individuals, have on language beliefs and practices. Ultimately, language policy can induce changes in linguistic behavior. In the family environment, this language management can come directly or indirectly, for instance, by means of correcting a child if they use non-expected language, or by more obvious forms of reward or punishment.

2.2 The effect of the Covid-19 pandemic on families' language practices and management

In the previous section we acknowledged that parental linguistic ideologies may influence language practices and policy in the household. However, other factors outside the family nucleus can have an impact on language use. Spolsky (2019: 323) has described that language policy "may be blocked or hampered by non-linguistic forces such as genocide, conquest, colonization, introduced diseases, slavery, corruption and natural disasters." The global Covid-19 pandemic could be considered an example of a "non-linguistic force" that affected language in the home. In some cases, homeschooling, remote work, and social-distancing measures directly increased exposure to home languages, while at the same time limiting families' ability to interact with a diverse group of speakers in the minority language, such as their relatives abroad.

The effects of the Covid-19 pandemic have been observed across a range of factors ranging from language acquisition to mental well-being. An example is von Soest et al. (2022) who explored the effect of gender and SES on adolescents' social satisfaction and well-being in Norway. Their results revealed that girls and adolescents from lower-SES families were more likely to experience adverse effects as a result of the pandemic. In a study investigating the stressors of the pandemic in family well-being in the United States, Crandall et al. (2022) found that positive associations towards family well-being decreased the risk of anxiety and depression. In the realm of language, Kartushina et al. (2022) showed an increase in vocabulary growth for infants across 13 countries

during the first lockdown of the pandemic, which, in their study, was defined from March to September of 2020.

At the level of emotions, research indicates that positive attachments towards a language can impact positively speakers' well-being as well as language outcomes. For instance, Dewaele & Costa (2013) showed that the ability to speak more than one language can, in fact, create a certain level of detachment from upsetting or traumatic experiences. This is a beneficial resource in psychotherapy sessions where such experiences are recounted (Dewaele & Costa, 2013). Moreover, positive attitudes towards multilingualism in early childhood can contribute to linguistic well-being and a more resilient multilingual identity (Hollebeke, et al., 2020; De Houwer, 2020). Multilingualism and well-being are tightly connected to families' socio-emotional well-being. Families that are able to establish a strong bond to the heritage language and culture are more likely to experience consistent family cohesion, which in turn can lead to better outcomes in the home or heritage language (Tannenbaum & Berkovich, 2005).

These studies show that the Covid-19 pandemic, as described by Spolsky (2019), was an external force that could have impacted language practices and management in the family environment. However, there is some evidence to suggest that positive associations towards family well-being can act as protective mechanism under dire circumstances (e.g., Crandall et al., 2022), and that a positive attachment to the language can create a more resilient multilingual identity (e.g., Hollebeke, et al., 2020; De Houwer, 2020), and ultimately support linguistic outcomes across the lifespan (Tannenbaum & Berkovich, 2005). In light of this research, parental ideologies towards multilingualism could have influenced the magnitude of the impact of the Covid-19 pandemic in the language use of multilingual families.

2.3 Cognitive control mechanisms in bilinguals. Are there cognitive benefits to bilingualism?

The previous section offered some insights into how positive beliefs around multilingualism can have a beneficial effect on speakers' linguistic identity and overall well-being. Cognitive approaches to bilingualism have considered whether the ability to speak more than one language poses any kind of general cognitive benefits. In fact, there is a large body of research investigating

whether bilinguals exhibit better cognitive performance as compared to monolinguals, claiming that speakers can train their cognition through bilingual language use, specifically language switching (Bialystok et al. 2009; Bialystok & Viswanathan, 2012). This claim is what has come to be known as the question of "the bilingual cognitive advantage." Despite the large quantity of studies reporting such bilingual advantages, this claim has been questioned by numerous systematic investigations and meta-analyses, (e.g., de Bruin et al., 2015; Donnelly, et al., 2019; Gunnerud et al., 2020; Lehtonen et al., 2018; Lowe et al., 2021; Monnier et al., 2022; Paap et al., 2013; 2018). The more fundamental question of the bilingual advantage claim is that it relies on two assumptions. First, that bilingual language control (e.g., in language switching) *relies on* domain-general cognitive control. Second, that bilinguals can *train* these domain-general cognitive control mechanisms by means of language switching.

The first assumption follows a hypothesis that has a fair degree of support in the field of bilingualism and language research, the domain-generality hypothesis (Green, 1998; Green & Abutalebi, 2013). This hypothesis posits that bilingual language control relies on general cognitive mechanisms, specifically, executive functions (EFs). The main three executive functions, as described by Miyake et al. (2000) (Figure 1) are inhibitory control, working memory updating, and cognitive flexibility. Inhibitory control relates to the ability to inhibit irrelevant information to the task at hand. Working memory updating is referred to as the ability to update the information provided by external cues for decision-making. Cognitive flexibility, also known as shifting, concerns the ability to switch between tasks in an efficient manner. While these executive functions might be involved simultaneously in the processing of certain tasks, they might not do so to the same degree. The assumption that two languages are always co-activated in a bilingual's mind implies that in order to produce a word in the desired language, bilinguals need to suppress or inhibit the other language. A widely used model to explain language switching is the Inhibitory Control model (Green, 1998) (Figure 2), which assumes that domain-general executive control modulates language-specific behaviors, such as switching, in a top-down manner. For instance, it is generally assumed that inhibitory control is necessary to suppress the other language and prevent its distracting influence when using one language, while language switching itself resembles how individuals shift between non-linguistic tasks.

Closely related to the Inhibitory Control model is the Adaptive Control Hypothesis (ACH) (Green & Abutalebi, 2013), which proposes that executive functions are not recruited to the same degree for different contexts (see Figure 3). This hypothesis distinguishes three interactional contexts: a single-language context, a dual-language context, and a dense code-switching context. In the first context, each language is usually reserved to one or several specific environments, but the two languages are not usually used simultaneously. This is, for instance, the case for speakers who use one language at work or school, and the other language at home with family. In the second context, two languages may be present in the environment, but they are usually spoken by different interlocutors. A typical example of a dual-language context is multilingual families who tend to follow a one-parent-one-language strategy. The child uses both languages at home, but each language is reserved for a specific speaker (a parent). In the third context, both languages are present and either of them may be used with the same interlocutor. Examples of this are bilingual communities, such as certain regions in Spain like Catalonia, where many speakers might be able to understand, and possibly speak, both Catalan and Spanish. In the dense code-switching context, a break in communication is less likely, given the interlocutor's ability to understand both languages. The ACH describes that eight different control processes may be involved in these contexts: goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, task engagement, and opportunistic planning. However, not all contexts create the same levels of cognitive demands on the speaker, neither do they engage the same number of control processes. In fact, the dual-language context is considered to be the most taxing one for EFs, as it assumedly engages all eight processes because it requires more constant awareness of the context, and the interlocutor's needs, to control and choose the intended language. Non-voluntary cued language switching tasks in the lab are considered to resemble the dual-language context, as in these tasks, the correct language to be used is governed externally. This is the context used in Studies II and III.

Figure 1. Executive functions based on Miyake et al., (2000) "unity and diversity approach." In this figure the focus is on the two components (blue) that are considered in the literature to be important functions in language control, inhibition, and shifting. I exemplify these two components with tasks that are used in this dissertation. *Note:* DCCS: Dimensional Change Card Sort test.

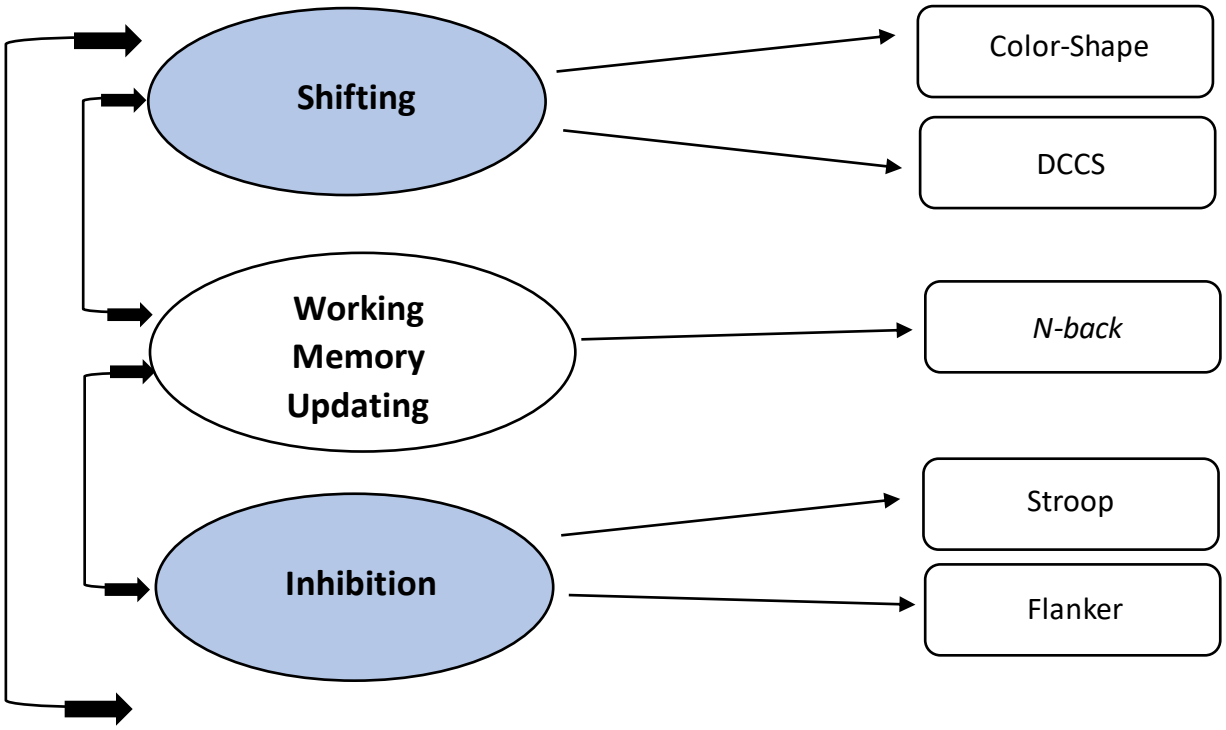


Figure 2. The inhibitory control model (adapted figure from Green, 1998).

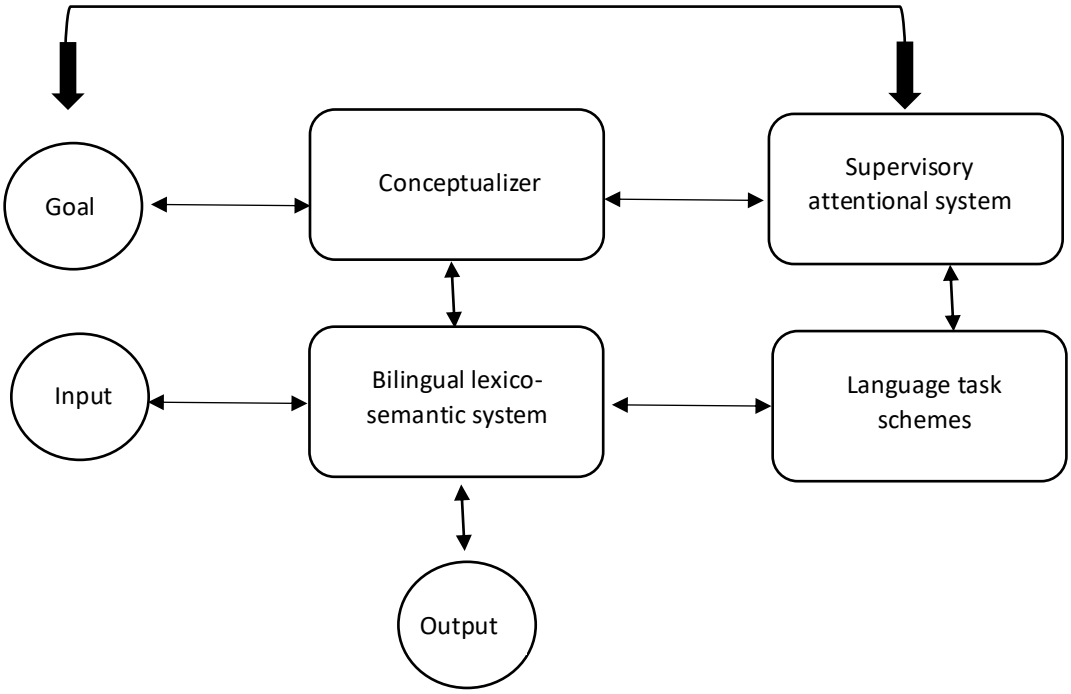
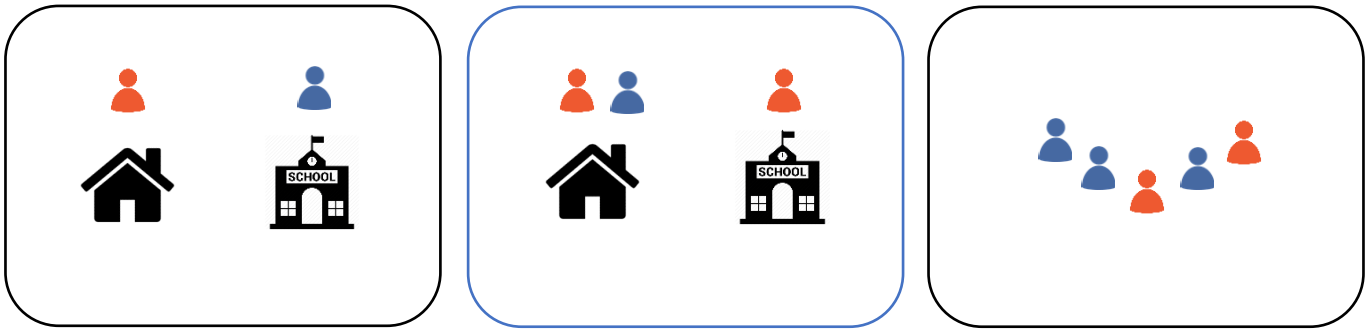


Figure 3. Interactive contexts based on The Adaptive Control Hypothesis.



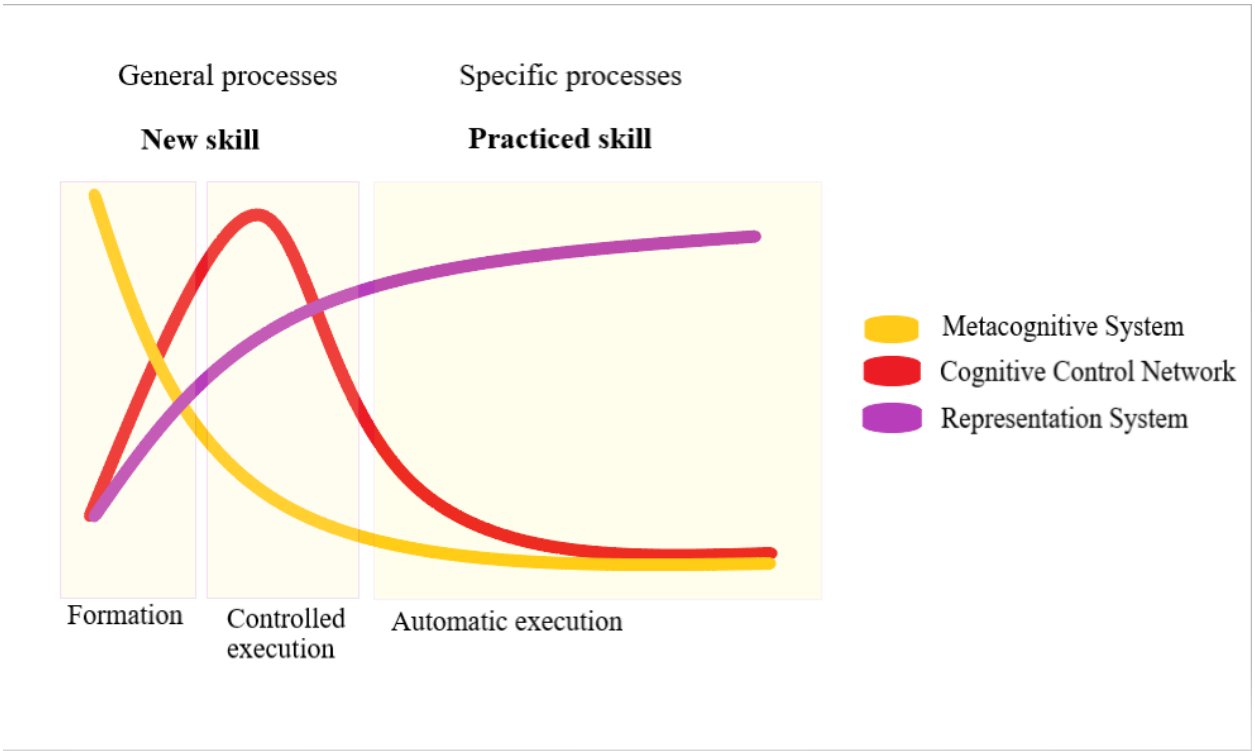
a) Single context b) Dual context c) Dense context

2.4 Are executive functions required for language control? An alternative approach to domain-generality

An alternative hypothesis to the task-generality approach addressed in the present thesis is the skill learning account. Research in psychology has proposed theories on the trajectories of human learning. An example is Chein & Schneider's (2012) Triarchic Theory of Learning, which

establishes three stages of learning of new behaviors that can eventually become automatized. These stages are the metacognitive system, the cognitive control network, and the representation system (see Figure 4). Chein & Schneider suggest that these stages provide a pathway for automatization of novel tasks. While their model explains the role of different brain regions in the process of learning, they do so in association with cognitive systems. For instance, EFs are likely engaged in the learning of novel tasks before new behavioral routines can be established. In his Controlled Dosed Hypothesis, Paap (2018) elaborates on how the learning of new tasks may boost EF ability in the early stages of learning to facilitate the configuration of the new task, but this boost does not necessarily remain over time. Building on Chein & Schneider's automaticity account, and Paap's hypothesis, Lehtonen et al. (2023) bring forward the skill learning hypothesis, which presupposes that bilingual behaviors gradually rely less on EFs the more the speakers have experience of these tasks. For speakers who are in the early stages of learning a second language, EFs might be involved the same way they would in the first stages of familiarization with a new task. However, with accumulating bilingual experience, bilingual behaviors such as language switching may become a very familiar and automatic process, and EFs might no longer be needed. The skill learning account sees bilingual language behaviors as skills that can become automatic with time and practices. Thus, this hypothesis assumes that cognitive processes are complex but adaptive, and that they may change based on speaker's experience.

Figure 4. Learning stages in the skill learning theory according to Chein & Schneider (2012) and Lehtonen et al. (2023) (Adapted from Chein & Schneider, 2012).



Importantly, the domain-generality and skill learning accounts are not incompatible, as bilingual behaviors might sometimes indeed rely on executive control, but perhaps not as extensively as the generality account assumes. Some inconsistencies that have been observed in the results of previous research on EFs and language switching might be explained by differences in the bilingual experience, age, and even pathologies of the speakers.

The skill learning hypothesis makes specific predictions about the degree of EFs and language control associations depending on a) language proficiency, b) age, c) pathologies, and d) task type (Lehtonen et al., 2023). It also predicts what kinds of e) training gains can be expected (Lehtonen et al., 2023). Less robust associations are expected between language switching and EFs for very proficient or experienced bilinguals, whereas children or L2 learners in the early stages of learning should be more likely to engage EFs in language switching. In contrast, the domain-generality hypothesis makes no explicit differentiation across proficiency levels. When it comes to age, younger bilinguals, who have not yet accumulated much bilingual experience, should exhibit stronger EFs associations with language switching than elderly bilinguals with decades of bilingual language use. The domain-generality account does not assume different involvement of EFs in

language switching based on age. Furthermore, the skill learning account does not expect that impaired bilingual language control is necessarily related to impaired executive control. In contrast, domain-generality directly expects impaired executive control to influence bilingual language control as well. When it comes to task type, the skill learning account expects associations between tasks of the same structure only, such as language switching and non-verbal switching tasks. The domain-generality view, however, expects associations between tasks tapping into the same EF component, for example, inhibition. Lastly, training gains are expected between tasks that are structurally similar in the skill learning approach. However, training gains under the domain-generality hypothesis are expected for tasks tapping into the same EF component, regardless of whether the tasks share a similar structure or not.

In their review article, Lehtonen et al. (2023) report that, while results are somewhat mixed, studies investigating associations between bilingual language control and EFs are more consistent with the skill learning hypothesis than with the domain-generality approach; that is, associations between switching costs and EF tasks are not found consistently, and one of the reasons could be participants' differences in language proficiency and overall bilingual experience. For children, however, broader associations are likely to appear, as they have not had time to accumulate a great deal of bilingual experience yet, which could align with both accounts. In contrast to language switching, Lehtonen et al. (2023), however, suggest that language monitoring, which is measured through so-called mixing costs in a cued naming task, may be less likely to become automatized. That being said, the majority of the reviewed studies were not intentionally designed to test the skill learning hypothesis, and it is difficult to interpret the reviewed evidence as direct support for the skill learning hypothesis.

2.5 Previous studies on language switching in adults

The majority of the literature investigating associations between language switching and executive functions has been gathered via lab-controlled experiments on adult populations. Such experiments usually compare cognitive task performance with performance in picture naming switching tasks. By using single-language and mixed-language conditions and three different trial types – single, repetition, and switch – it is possible to obtain two measures of language switching performance: switching and mixing costs. Switching costs are the difference in accuracy rates or reaction times

between switch and repetition trials in mixed blocks, whereas mixing costs reflect the difference in performance between single trials in single blocks, and repetition trials in mixed blocks. This alternation of trial types elicits a processing cost. Mixing costs, commonly associated with monitoring, are interpreted as a reflection of proactive control or overall preparedness. Because it is obtained through the difference in performance between two blocks (one with language switches and one without), it can be understood as the sustained control processes necessary to shift tasks.

While lab-controlled picture-naming tasks are commonly used as a measure of language control, it is difficult to say whether they are an ecologically valid measure (Blanco-Elorrieta & Pylkkänen, 2018). Part of the critique is whether artificially constructed switching paradigms can, in fact, reflect real life language switching. Furthermore, the environment around task performance in the lab might be tainted by the lack of naturalistic conditions that exist in real life communications. Nevertheless, much of the research on language switching uses a cued-picture naming paradigm. Below, I present previous studies' findings and what they might tell us, or not, about the associations between language switching and EFs.

In the last decade, several studies have found evidence to support the domain-generality hypothesis by means of associations between language switching and tasks tapping into executive control. For instance, Linck et al. (2012) found that a smaller Simon effect, which is an indicator of better inhibitory control, predicted smaller switching costs in a group of English-French-Spanish trilinguals. This means that participants who showed better performance in the EF task also exhibited better performance in cued naming. Furthermore, Declerck et al. (2017) found switching cost associations with a non-verbal task across a group of German-English bilinguals, which was taken as evidence for the role of cognitive control in language switching. In a subsequent study, Declerck et al. (2021) reported significant associations between a language switching task and a non-verbal color-naming task of identical structure in English-Spanish bilinguals, again suggesting that language switching relies on domain-general cognitive control. In another group of trilinguals using MRI, language switching and EF tasks, de Bruin et al. (2014) found that areas of the brain associated with inhibition were activated during language switching.

While the studies above are some examples showing associations between language switching and EFs, several other studies have found no associations between the two. For instance, Magezi et al. (2012) found no associations between language switching and non-linguistic shifting ability in

bilinguals with significant L2 experience. Similar findings were reported by Calabria et al. (2012), where language control was not reliant on domain-general executive control. Moreover, Branzi et al. (2016) found that language switching was not predicted by a non-verbal switching task in a group of bilinguals with high proficient L2 and medium proficient L3. More recently, Jylkkä et al. (2018) explored EFs and language switching in Finnish speakers who had learned the L2 after age 9, but who had relatively high proficiency in the language. While the authors found results did not fully align with the IC model, they argued that conflict monitoring is contributory in language switching for bilinguals. In a later study, Jylkkä et al. (2021) explored language control and domain-general cognitive control in a similar population of bilinguals. In this study, more consistent EF and language control associations were found for mixing costs than for switching costs.

What the last studies have in common is that the sample populations had various degrees of L2 experience, which could hint at why some of them find associations and others do not. However, they do not directly address the role of proficiency in the EFs-language control associations. To my knowledge, only one study has directly explored what the role of L2 experience might be in the presumed associations between language control and domain-general cognitive control. Wang et al. (2022) investigated whether performance in a Simon task predicted language control in a group of Chinese-speakers with high and low English proficiency. The results indicated that the Simon task performance predicted switching costs in the low-proficiency group, but not in the high-proficiency group, thus suggesting that high-proficiency bilinguals rely on EFs to a lesser extent than low-proficiency ones.

The authors interpreted this result as evidence that highly-proficient bilinguals rely on domain-general control for language control less than speakers with lower L2 proficiency, a process that is representative of the development of a second language in bilinguals. In contrast, the Simon task predicted mixing costs in the high-proficiency group. This could be interpreted to support the skill-learning account, where the high-proficiency participants' language switching is relatively automatized and not relying on EFs anymore, whereas for the low-proficiency group, language control is more effortful and still engages EFs.

All in all, these studies offer evidence that EFs are not necessarily required for bilingual language control and, given the various types of language experience in the samples, suggest that bilingual language experience and L2 proficiency could be an influential factor in this relationship.

2.6 Previous studies on language switching in children

Research investigating the associations between language switching and EFs in children is fairly limited. In a longitudinal study with 31- to 61-month-old children, Kuzyk et al. (2019) found that proficiency influenced code-switching, and that more exposure to code-switching led to worse inhibitory control performance, which was measured with a Flanker task. In a study with 4–5-year-old Spanish-English bilinguals in the United States, Gross & Kaushanskaya (2020) used an interactive dialogue scripted paradigm and found that language proficiency was the main predictor for language switching. While a DCCS task was included, the authors suggested that cognitive control plays a limited role in comparison to proficiency. Bosma & Blom (2019) found that the frequency of switching in 5-6 year-old Dutch-Frisian bilingual children was associated with performance in a Flanker task. Using a Flanker task, they reported that the frequency of switching and asymmetric costs were associated with cognitive control. Furthermore, Kaushanskaya & Crespo (2019) explored how exposure to language switching in children's environments could influence language skills. Language proficiency, WM, and non-verbal intelligence of 5-11-year-old children were tested in the lab. The results showed that for children with high WM, code-switching exposure was associated with better language skills, whereas for children with low WM, code-switching was negatively associated with language performance. These studies show that language switching in children, measured by parental reports or free-play sessions might be explained partially by executive control, but that proficiency may be a better predictor for children's language switching behavior. Furthermore, some of these studies explore the potential effect of parents' language practices, by means of exposure to language switching, as a potential factor influencing children's language control in association to domain-general cognitive control. Nonetheless, while measures of language switching such as parental reports and free-play sessions might be more ecologically valid to a certain extent, it is difficult to create a link to the findings on language switching performance reported in adults.

In contrast to spontaneous or parent-reported switching, studies that have measured language switching performance in the lab in children and included EF measures are scarce. Gross & Kaushanskaya (2018) used a cued naming paradigm to assess the effect of non-linguistic task shifting in bilingual language control in Spanish-English speaking children. Their study showed that non-linguistic shifting predicted language switching performance. Moreover, Kubota et al. (2020), explored whether development in executive control and bilingual experience predicted language control in bilingual returnee children, which the authors defined as children who returned to their L1 after spending some years in an L2 environment. A forced cued language switching task and a Simon task showed that cognitive development overall predicted language control, suggesting an overlap between executive control and language control. They found mixing costs that predicted L2 performance and were modulated by improvement in performance in the Simon task. Their results seem to support the view that EFs are involved in language switching in children to some extent.

There is very limited research testing cued naming in the lab in connection to EFs. The few studies exploring this relationship show some evidence that associations between EFs and language control might exist in children (e.g., Gross & Kaushanskaya, 2018; Kubota et al., 2020). This finding is in line with Lehtonen et al.'s (2023) review paper that younger, less experienced bilinguals might rely on EFs for language control to a larger degree than those with prolonged bilingual experience. However, studies that measure language control in the lab have not explored a direct connection between children's language control, their EF performance, and whether they both might be associated with characteristics of their linguistic environment, specifically, the language practices between parents and children. Thus, we lack in-depth understanding as to whether language control in children, as measured in the laboratory, may be associated with domain general executive control as well as their everyday language control ability at home.

2.7 Summary

Different theoretical approaches to the study of multilingualism can offer a window into understanding the factors that influence language development and use in multilingual speakers. Sociolinguistic approaches to multilingual development, such as FLP, have shown that language use and language maintenance in children are influenced by parental ideologies and the language

practices enabled in the family nucleus. Such ideologies and practices are not independent from language ideologies and policy at the societal level, which ultimately shape individuals' own multilingual identity.

Language practices between parents and children, such as how much parents choose to ascribe to a one-language-one-parent practice or a more relaxed towards language mixing, may offer insights with respect to the contexts in which children use their languages. This information, in turn, may help give us a measure of children's everyday language control ability and help us study associations between bilingual language control and domain-general EFs from an increasingly ecologically valid perspective.

Much of the previous research on language switching has assumed that domain-general executive functions are engaged in bilingual language control (i.e., domain-generality account). However, contrasting evidence in adult studies shows that EFs might be required for language control to some degree, but the circumstances under which this might occur are unclear. The limited evidence on language control in children indicates some evidence in support EFs required for language control, but there are not sufficient studies assessing language control and EF performance in the lab.

The conflicting evidence in regard to the role of EFs for language switching indicates that the domain-generality account might not fully explain the role of executive control in language switching. In this dissertation, we test experimentally whether the skill learning hypothesis can better explain the relationship between these two constructs.

2.8 Research questions and aims of this dissertation

The multilingual experience is not a homogenous one. Whether it is the context and age of acquisition, the degree of bilingual use on a day-to-day basis, the extent to which speakers switch languages, the emotional attachment to each language, and the number of languages they might use, these are all factors that make no two multilinguals alike. However, neither the diversity of these experiences nor the different methodological approaches that measure them are always considered when research attempts to make generalizable claims about multilingualism.

This dissertation has two main purposes. First, it provides a window into multilingual development across the lifespan by adopting a cross-sectional approach that addresses different age groups. Second, it uses both sociolinguistic and psycholinguistic theoretical approaches to the study of multilingual language use and processing. Study I adopts a sociolinguistic approach within the Family Language Policy framework. Studies II and III, in turn, are framed under cognitive approaches to bilingualism, but considering the role of the social factors and language use in the links between language and cognitive processing. In combination, the three studies offer a perspective on the socio-environmental and cognitive factors that shape multilingual language use across the lifespan.

In this dissertation, I aim to answer the following questions:

1. How do external factors such as the Covid-19 pandemic influence language attitudes, practices, and policies in the family environment influence children's language?
2. What is the relationship between language switching and executive functions in bilingual children?
    a. To what extent are executive functions associated with bilingual language control in children?
    b. Is this relationship similar when measuring children's bilingual language control in everyday settings, as when taking into account the language practices in the family environment?
3. What is the relationship between language switching and executive functions in bilingual adults?
    a. To what extent are executive functions associated with bilingual language control in adults?
    b. Do factors such as language proficiency influence this relationship?
4. How can questions 1, 2, and 3 inform us about potential benefits of bilingualism?

In the following section, I describe the characteristics of the different participant samples and relevant ethical considerations for the collection of data, as well as the methodologies used for the

three studies included in this dissertation. Section 4 provides a summary of results for each individual study. In Section 5, the results of the individual studies are interpreted according to current theories and discussed in connection to the research questions formulated above.

3. Method

3.1 Participants

Participants were recruited through different platforms. For Study I, multilingual families and children in Norway were mostly recruited through different social media platforms such as Facebook and Instagram. For the Norwegian sample in Study II, we were able to contact a significant number of families with multilingual children via science dissemination events, as well as language-specific activity groups aimed at providing additional exposure to children's home languages. Some participants were contacted though MultiLing's Socio-Cognitive Laboratory's general participant pool. Others were recruited through video posts shared on the Facebook pages of MultiLing and the Spanish Embassy in Oslo. Parents provided digital consent prior to participation in the online survey in Study I. For Study II, parents provided digital consent for their children to participate prior to coming to the lab. The adults in Study III gave digital consent at the beginning of the online experiment.

The sample in Study 1 consisted of 193 multilingual families in Norway. The final sample included 188 families (Mean age of the child = 5.9 years, SD = 4.1 years) after exclusion of 5 families who reported their children had special needs, developmental, or learning difficulties. Given the nature of the study, it was not possible to assess our research questions without a representative sample of families that reported diagnoses. A total of 45 languages were represented in the sample, and families from all regions in Norway participated in the study (See Table 1; Figure 5). The greater Oslo region was significantly more represented due to the high percentage of foreigners living in Oslo, and its linguistic diversity. The presence of languages at home varied from 2 to 5, although the majority of families (67%) used two languages in the household. For 56% of the sample, Norwegian was a language present at home.

Table 1. Distribution of responses per region

Region	Total responses	Percentage (%)
Eastern Norway outside Greater Oslo Region	18	10
Greater Oslo Region	106	57
Northern Norway	12	6
Southern Norway	4	4
Trøndelag	8	4
Western Norway	39	21

Figure 5. Regions in Norway

Study II included two samples of Norwegian-Spanish and Finnish-Swedish speaking-children that were collected in Oslo, Norway, and Turku, Finland, simultaneously. In total, 45 children (26 in Finland and 19 in Norway) were included in the study (Mean age = 76 months; 23 boys). Children were excluded if the parents reported any learning and cognitive difficulties such as ADHD, autism spectrum disorder, or hearing or visual impairments. Linguistic inclusion criteria required children to be able to hold a conversation in the relevant language pair, but we did not exclude children who were exposed to other languages. Most children had acquired the languages of interest from birth, with some exceptions where one language had been acquired within the first 2 years of life.

In Study III, 85 Finnish-Swedish adult bilinguals (Mean age: 24; SD: 5.3; 69 women) participated in an online experiment. To explore whether proficiency influenced EFs-language control associations, the sample was initially studied as a whole, but later divided into three groups: an early bilingual group that had acquired both languages in early childhood (*n*= 24; Mean AoA = 0.75; SD= 1.33), and a L2 group who had acquired Swedish later in life. This group was divided into high-proficient L2 speakers (*n*=30; Mean AoA = 11.97; SD= 1.45), and low-proficient L2 speakers (*n*= 31; Mean AoA = 12.48; SD= 1.67) based on their vocabulary scores and self-reported proficiency. These measures were highly correlated (r=0.87). Most participants in the early bilingual group were students at Åbo Akademi University, the Swedish-language university in Turku, Finland. Most of the late bilinguals were students at the Finnish-speaking University of

Turku in Finland. Participants were excluded if they reported hearing or visual impairments that would interfere with the nature of the experiment.

Table 2. Descriptive information of participants

Variable	Study I	Study II	Study III
N	188	45	85
Age (years)	5.9 (4.1)	6.3 (0.53)	24.1 (5.3)
Location of data collection	Norway	Norway / Finland	Finland

For all studies, background information on language use and exposure to the language(s) of interest was collected. This information was used to create language related predictors that were included in the statistical analysis. In Study I, this information was only reported to describe the sample. In Study II, this information was used for variables on language switching that were used as predictors for some of the statistical models. A summary of numbers of participants, place of testing and Mean age is presented in Table 2.

3.2 Materials and procedure

3.2.1 Online Survey for Study I

The online survey *Language in Multilingual Families during the COVID-19 Pandemic in Norway* was provided in English and Norwegian, but 70% of the families responded in English. Data were collected between 18 May 2020 and 30 June 2020, following the first lockdown in Norway that impacted kindergartens, schools, and high schools between 12 March 2020 and 11 May 2020. Participants were instructed to reflect on their experiences during this time period which was, at the time, the only lockdown. The survey consisted of four sections: 1) background and demographic information, 2) questions regarding language beliefs and ideologies, 3) questions regarding language practices at home during the pandemic, and 4) questions targeting the impact of the lockdown and social-distancing measures. The survey was adapted from a questionnaire developed by colleagues in The UK and Ireland to fit the Norwegian context. Some additional questions were included regarding the specific role of English for families in Norway, given that

this is a language frequently used in the country, and is the language of communication for many caregivers.

3.2.2 Language switching experiment in children (Study II)

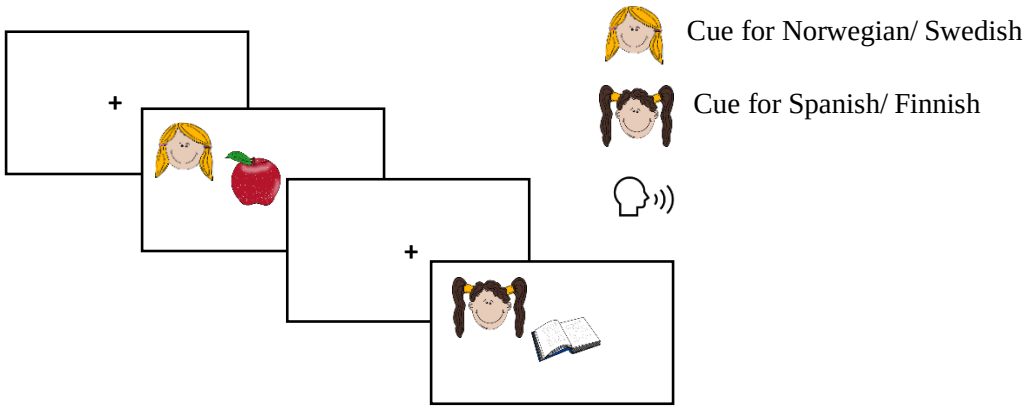
Children completed the experiment over two one-hour sessions that took place within a maximum two-week period. In Norway, children came to the Socio-Cognitive lab at the University of Oslo, whereas children in Finland performed the experiment in the kindergarten, in a quiet room. One session consisted of the language switching task as well as the Cross Linguistic Lexical Tasks in the two relevant languages. In the other session, children completed all four cognitive tests in the language they were most comfortable in. The order of the sessions, as well as the order of the cognitive tests, was counterbalanced.

Cued picture naming paradigm

A cued picture naming (CN) task was used to measured children's language switching in the lab. The task consisted of two types of blocks: two single-language blocks where children were required to name pictures in language A or B, followed by three mixed blocks where children were required to switch languages, depending on the visual cue. In adult studies, a picture of a flag is typically used to indicate the target language. To make the task more child friendly, we used drawings of two girls (see Figure 6) who the child was told could only understand language A or B in the instructions. The girls were given a name that was frequent in the language of interest, e.g., Ane for Norwegian, Laura for Spanish, Aino for Finnish, and Ebba for Swedish. We used 20 individual pictures from a set of Multipic's Project (Duñabeitia et al., 2018) standardized pictures. In the single blocks, the pictures appeared once, whereas in the mixed blocks the picture appeared twice, once in each language. There were a total of 160 trials. The task allowed us to obtain accuracies and RTs for each block. For the analysis, we chose accuracy as our main dependent variable since previous research has suggested that accuracy is a better index of performance than RT in young children (Gross and Kaushanskaya, 2020; Diamond & Kirkham, 2005; Davidson et al., 2006). Accuracy performance was thus used to obtain two measures: switching costs, or the difference in accuracy performance between switch and repetition trials in the mixed blocks, and mixing costs, or the difference in accuracy performance between single trials in single blocks and repetition trials in mixed blocks. Switching and mixing costs were later used to examine possible

associations between cued naming performance and EF performance and everyday language switching ability.

Figure 6. Example of a repetition trial in language A followed by a switch trial in language B for the cued naming task for children

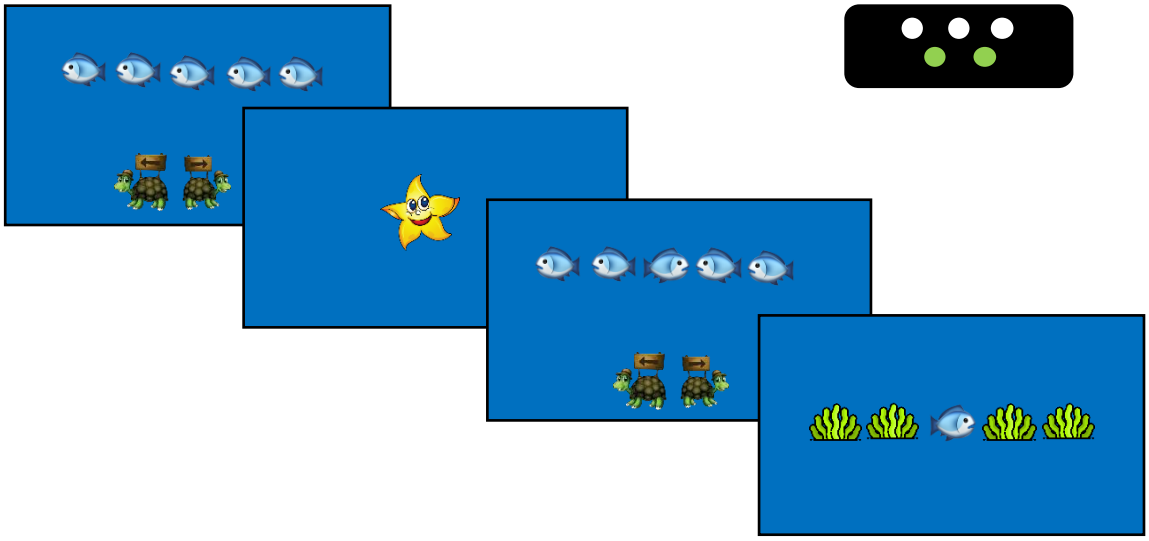


Executive Functions measures

Flanker task

A child-friendly adaptation of Eriksen & Eriksen (1974) Flanker test was used in the experiment. In our version, children saw five fish on the screen and had to correctly choose the direction of the fish in the trials by using the left or right button in the response box. In congruent trials, all fish swam in one direction (right or left) (e.g., >>>>>), whereas in incongruent trials the central fish swam in the opposite direction (e.g., >><>>). In addition, neutral trials were added where picture of vertical seaweed substituted all but the central fish. In this task, the fixation cross in between trials was replaced by a picture of a starfish (See Figure 7 for a visual example of the task). Each of the three conditions included 20 trials. From this task we obtained the Flanker effect, which is the difference between the congruent and incongruent trials measured by means of accuracy rates or RTs.

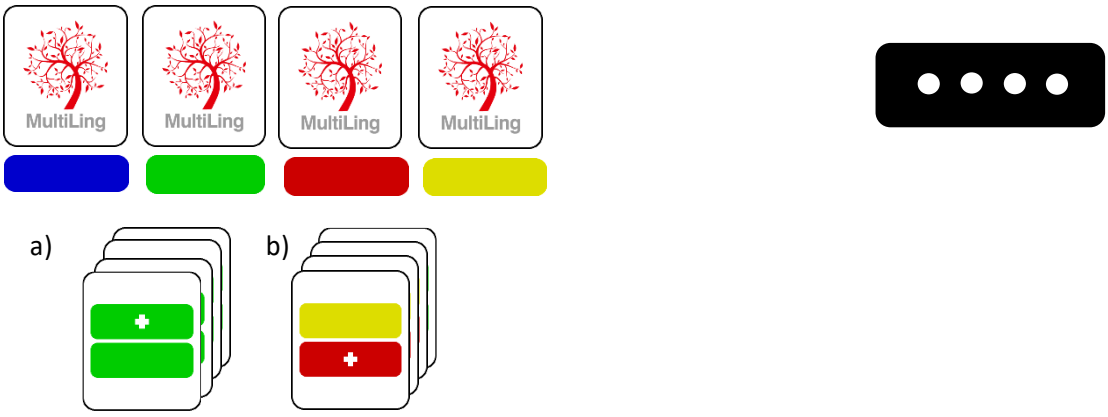
Figure 7. Example of congruent, incongruent and neutral trials in the Flanker task



Non-verbal Stroop Card Sorting Test

We adapted and computerized the commonly used inhibition Non-verbal Stroop Card Sorting Test (NSCST), which can be used for a wide range of ages (3-70). The NSCST is a version of the traditional Stroop task, where words of colors in different inks appear in the screen which is particularly friendly for children as it does not require the ability to read. The cards included cards with rectangles in different colors, which the child participant was required to sort. In the congruent phase, the child was asked to sort the cards based on the unique color present in the card, whereas in the incongruent phase, two colors appeared on the card, and the child was required to sort the card based on the colored rectangle that has a white cross on (Figure 8). This test allowed us to obtain the Stroop effect, the difference between performance in congruent and incongruent trials and is considered an index of inhibitory control.

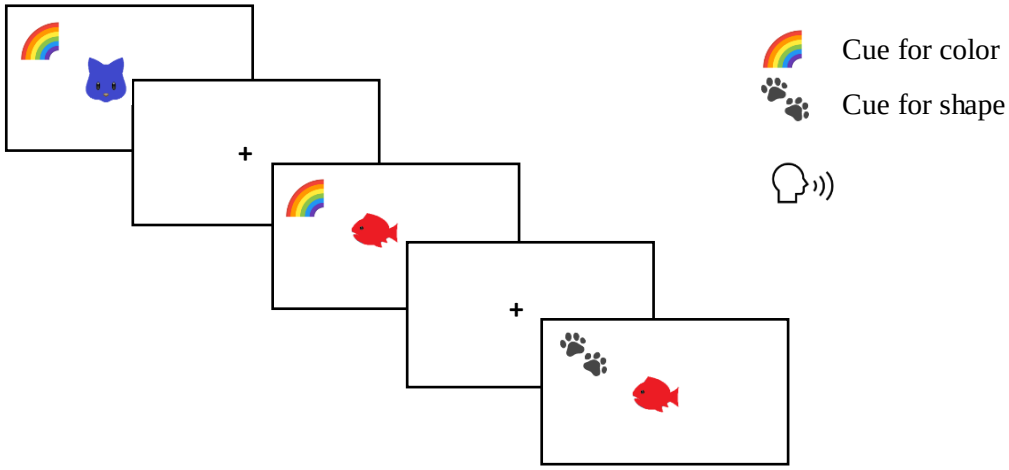
Figure 8. Example of congruent (a) and incongruent (b) conditions in the NSCST



Color-Shape task

We adapted the traditional color-shape (CS) task to match the cued naming task as much as possible. As in cued naming, the task consisted of two single blocks and three mixed blocks, and required the participant to give oral responses. The visual cues for the different conditions were a rainbow for the "color game" and a paw for the "shape game," and the target responses included a fish or a cat in either red or blue. In the single color block, children were required to respond blue or red, whereas in the single shape block the child had to respond fish or cat. In the mixed blocks, the visual cue was alternated, forcing the participant to switch: they had to name the color they saw or the shape of the animal based on the visual cue (see Figure 9). The order of the blocks was counterbalanced, but the single blocks always preceded mixed blocks. As in the cued naming task, we used accuracy performance as our main dependent variable for the analysis. With this task we obtained switching from the difference in accuracy performance between switch and repetition trials in the mixed blocks, and mixing costs from the difference between single and repetition trials in the single blocks.

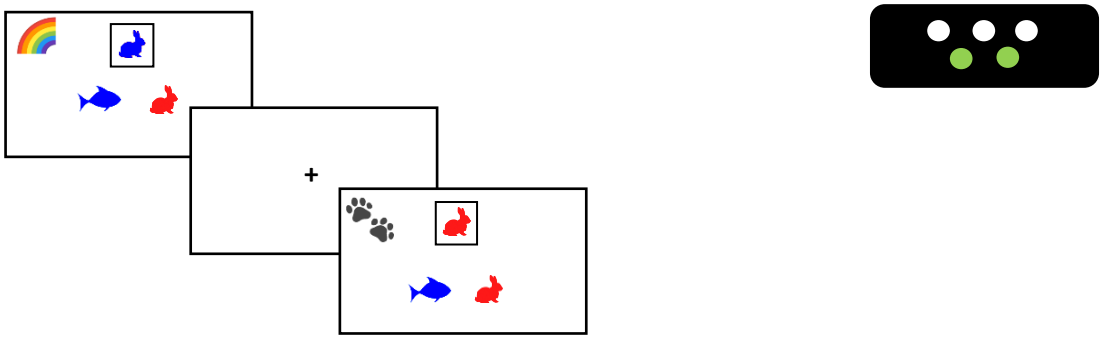
Figure 9. Example of a repetition trial followed by a switch trial in the mixed condition task for children



Dimensional Change Card Sorting test

We computerized a version of the Dimensional Change Card Sorting test (DCCS) similar to Park et al., (2018). This is a commonly used task to measure non-verbal shifting capacity in young children. Similarly to the color-shape task, children are required to play the "color game," or pre-switch phase, then the "shape-game," the post-switch phase, and finally a mixed phase where the visual cues (a rainbow a and a paw) alternate to provide unexpected switches (Figure 10). Contrary to the color-shape task, the order of the blocks was always the same (color, shape, mixed), and the responses were given using a response box.

Figure 10. Example color-cued trial followed by a shape-cued trial in the mixed condition for the DCCS task



Language and background data

The Bilingual Language Experience Calculator (BiLEC) (Unsworth, 2013) was used to obtain linguistic and background data of the children. The data were collected in an interview manner with the parents. We obtained information on SES of the parents, the degree of language use and exposure to the different languages of the child, as well as information on activities the child might do in different languages, and the speakers with whom they might interact in each language, especially the home or minority language. We used this data to determine which language the child might feel more comfortable using during the cognitive session of the experiment.

In addition to the BiLEC, parents responded to a questionnaire that targeted specific questions about language mixing at home, which allowed us to determine if and to what extent children had experience with a dual-language context (which we emulated in the cued naming task in the lab), and their everyday language control ability. The questions focused on parents' tendency to mix languages with the child, their willingness to encourage the child not to mix languages with them, and the degree to which the child fulfilled these demands. This data was used for the statistical models assessing the associations between cued naming in the lab and everyday language control ability.

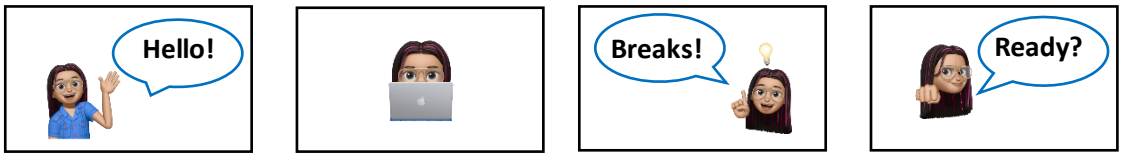
To determine children's proficiency in each language, children completed the Cross-linguistic Lexical Tasks in the relevant language pair. For the purpose of shortening the length of the session, children completed the sections of the task that measured production and comprehension of verbs only, and not nouns. Total accuracies were then used to determine language proficiency and dominance, which was used in the statistical analysis to explore potential asymmetries in switching and mixing costs in cued naming.

3.2.3 Language switching experiment in adults (Study III)

Participants completed an approximately one-hour long online experiment in the Experiment Builder platform Gorilla (citation). Participants were accompanied throughout the experiment with an "experimenter memoji" that gave instructions for the different tasks with explanatory videos

and text (see Figure 11 for a simplified example of how the instructions were presented. It is possible to access the experiment here (please enter your name).

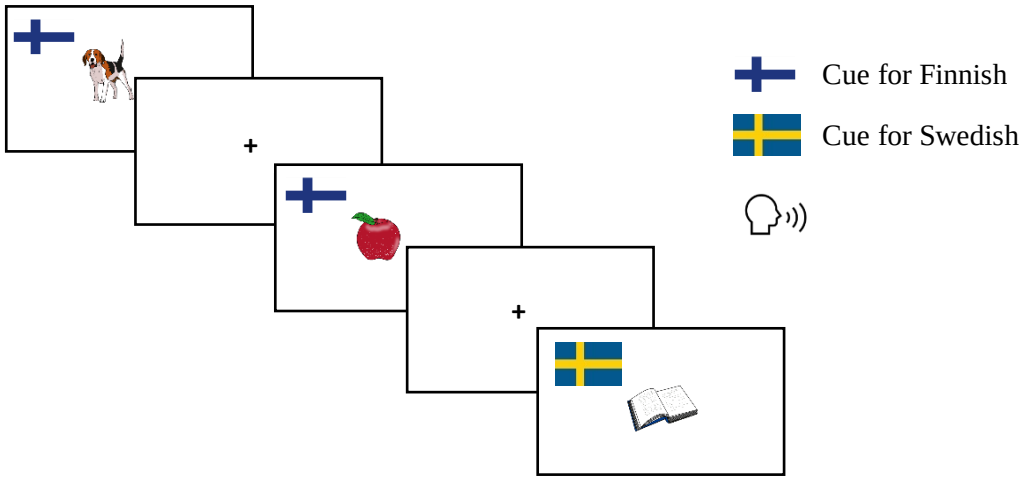
Figure 11. Visual adaptation of explanation screens where the "experimenter memoji" accompanied the participant throughout the experiment online



Cued picture naming paradigm

The cued naming picture task in the experiment for adults had almost the same structure as for the one for children, and the same stimuli were used as for the version of the task Finnish-Swedish children completed. The only substantial difference was the length of the task. In the experiment for adults, we increased the speed at which participants were required to respond, which was faster than for children, as it was important to assure the speed of the task would put enough cognitive demands on speakers to identify a potential association with the EF measure. Furthermore, two additional single blocks were added after the mixed blocks, which increased the number of trials from 160 to 200. The structured of the task was as follows: 2 single-language blocks, 3 mixed-language blocks, 2 single-language blocks. The addition of single blocks following the mixed blocks, in a sandwich-design like manner, has been suggested to provide a more reliable measure for mixing costs. Moreover, it provides additional information in regard to whether the participant improves performance as a result of task familiarization. In the child experiment, only 2 single blocks were used at the beginning of the task, as the length of the task and the child's ability to maintain focus were a concern. The visual cue in this task was a flag that indicated the target language (See Figure 12), mimicking adult studies typical design for this task.

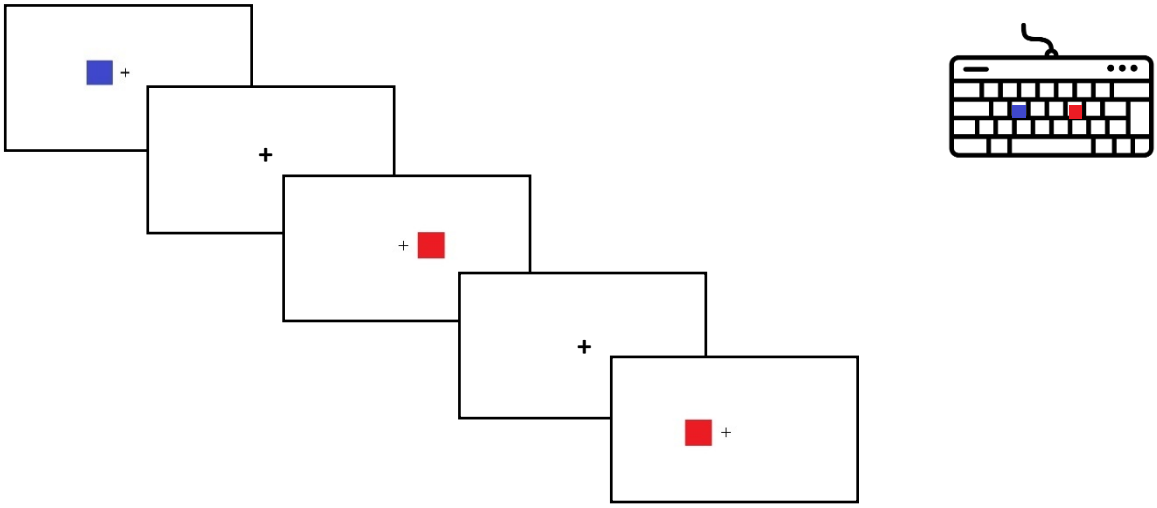
Figure 12. Example of a repetition trial in Finnish followed by a switch trial in Swedish for the cued naming task for children



Simon Color Square task

A Color Square Simon task (Simon & Rudell, 1967) was used to measure participants' inhibitory control. Participants were required to select the correct color of the stimulus, either blue or red, by using F or J on the keyboard respectively. A total of 100 trials were included in the task, as well as 10 practice trials. A fixation cross always appeared in the middle of the screen and the (color square) stimulus on either side of the screen. In the congruent condition, the stimulus was on the same side of the response key (blue appeared on the left and red on the right), whereas in the incongruent condition it was on the opposite side (blue appeared on the left and red on the right) (See Figure 13). We obtained the Simon effect buy measuring the difference in RTs of congruent and incongruent trials.

Figure 13. Example of Simon color task.



Language and background data

A language and background questionnaire were included in the experiment to gather data on participants exposure to and use of Finnish and Swedish, as well as other languages. Moreover, participants completed a short version of the Swedish Levels Test (SweLT 1.0; Bokander, 2016), which is a vocabulary test designed to challenge even advanced learners.

The vocabulary assessment and self-reported proficiency, which were highly correlated (r= 0.87), were used to determine the participants' Swedish proficiency for later analysis. A vocabulary test was used for its suitability for online data collection and because it has been shown to provide reliable evidence for language comprehension and communicative ability (Staehr, 2008).

The Swedish vocabulary test was used to divide participants into groups based on Swedish language experience and age of acquisition. The background questionnaire also provided information about participants' experience with switching. These questionnaires were always completed after the cued naming and Simon tasks.

3.3 Statistical analyses

The statistical analysis in Study I consisted of a matrix correlation analysis. Given the quantity and complexity of the questions in the survey, we carried out an Exploratory Factor Analysis (EFA) to identify the most relevant variables and create new aggregate variables on which to perform further

statistical analysis. The aggregate variables combined questions of the same type, such as language beliefs, questions about literacy, or questions about digital communication. In addition to the correlation analysis, some logistic regression models were used to further explore a more direct relationship between significantly correlated variables.

The pre-registrations of the statistical analysis for Study II can be found here. Some changes were made to the analysis plan, such as z-transformations of predictors of interest (e.g., EF measures, language proficiency and age) that facilitated convergence of mixed effects logistic regression models. The analysis remained largely similar to the pre-registered plan otherwise. The first question in this study focused on whether language switching in children could be explained by executive control, whereby language switching was measured with a cued naming task and executive control by four EF tasks. The second question explored whether everyday language control ability was associated with language switching in the lab and EF performance. For all models, CN accuracy was the dependent variable and CN condition (switch, repetition, single) was the predictor variable. In the models assessing EF associations, one EF measured was entered at a time in interaction with CN condition. Subject and item were always included as random effects, and age was entered as a covariate.

In study III, the research question was whether EFs were associated with language control, and whether this association was modulated by language proficiency. To address this question, we ran different mixed effects linear regression models for the entire sample as well as for different proficiency groups. In this case, CN RTs were always the dependent variable, and CN Condition in interaction with Simon effect was the predictor. Trial order was entered as a covariate in all models, and Subject and Item, as random effects. Incorrect RTs were removed from the CN task, and correct trials that deviated +/- 3 SD from the participant's overall mean were also excluded. Prior to fitting the model, correct RTs were log-transformed to correct for the normality of the residuals, and the Simon effect variable was z-transformed. For the models run on the full sample and the late-learner only sample, proficiency was added in interaction with CN condition and Simon effect.

3.4 Ethical considerations

Data collection procedures were assessed by the relevant bodies in the countries where it was collected. In Norway, the Norwegian Agency for Shared Services in Education and Research (Sikt) assessed the data processing. Sikt does not have responsibility for ethical approval of research studies, but is in charge of assessing whether the collection, processing and storage of data for research purposes is in accordance with GDPR data protection regulations. The projects and data collection in Finland were evaluated and approved by the Ethics Committee for Human Sciences at the University of Turku. The PhD candidate was responsible for data protection regulations and for gathering consent from participants or parents of underaged participants. Even though children were able to participate with parental consent, they were able to withdraw consent verbally during the session. The experimenters were careful to respect the child's wish to withdraw from participation. Participants were informed of the possibility to withdraw consent until data was anonymized. During the in-person experiments in the lab, parents were able to ask questions or express doubts about their study. Even when the session was carried out by a research assistant, the PhD candidate made herself available to meet the parents prior to or after the sessions to discuss any questions they might have. They also had the opportunity to do so over the phone or email at any given point.

4. Main features of the studies

4.1 Study I

This study examined how the Covid-19 pandemic and associated lockdown measures in Norway affected the language practices and beliefs of multilingual families. The study was based on Spolsky's tripartite model of language policy, and used an online survey to collect data from parents during the first lockdown in Norway. The results showed positive attitudes towards multilingualism and a positive impact of the lockdown on language practices in the home language. Promoting activities in both Norwegian and the home language during the lockdown was associated with positive effects on both languages. The study also found that viewing multilingualism as a source of well-being in the family was associated with positive effects on the home language. We recognize that the positive effects in our results might be influenced by the high SES of the families who completed the survey, the reasonably safe environment during the

pandemic in Norway with low levels unemployment and robust childcare support, as well as the overall positive attitudes towards multilingualism and linguistic diversity in the country. The authors acknowledge the limitations of using a survey to understand the complexities of multilingual families' experiences during the pandemic, but believe that the study offers a new perspective on multilingualism as a source of resilience and connection. They hope that the study's findings can serve as evidence of hope and resilience for other families across the world.

4.1.1 Comments to Study I

The study was designed with the particular interest of whether the use of home or minority languages in multilingual families, which are often relegated to a secondary space once children enter the schooling system, would have increased as a result of more time at home. This prediction was confirmed; however, we were somewhat surprised with respect to the results about Norwegian language use. In this sense, our sample was split into families for whom Norwegian was a language present at home and those for whom it was not. For the former, spending more time at home with their children as a result of remote work and homeschooling meant increased use of Norwegian and home language, while for the latter, the lockdown drastically diminished their exposure to, and use of, Norwegian. It is not uncommon in Norway for migrants to communicate in English, as the majority of the population, especially in Oslo, are fluent in this language. This essentially means that emigrants to the country do not necessarily learn and communicate in Norwegian right away. It is thus not striking that those families for whom Norwegian was not a language spoken at home were significantly impacted by the pandemic in their exposure and use of Norwegian.

A relevant point of consideration is to what extent the overall positive results in our study are generalizable to other countries and societal contexts. As already indicated, the sample in the study had a high SES, which can influence positive linguistic ideologies, but this is not the only aspect that can influence this result. While the pandemic had significant consequences across the world, it also highlighted how financial and social differences across countries dictated the magnitude of such consequences. In comparison to other countries, Norway did not experience the harshest effects of the pandemic. The country’s well-established welfare system, as well as the own government’s more relaxed lockdown measures, as compared to other countries, likely influenced these families’ experience of the pandemic, and provided more prosperous circumstances for these

positive effects to occur in the first place. It would be wrong to assume that families all over the globe experienced the privilege that these families established in Norway did.

4.2 Study II

The study investigated the potential relationship between children's language switching and executive functions (EFs), with a focus on cued naming and EF performance. A second goal of the study was to explore whether CN in the lab was associated with children's everyday language control ability as reported by the parents. The study did not find consistent associations between CN and EFs: two EF tasks positively predicted mixing costs in CN, the Flanker task and color-shape switching. Nonetheless, CN switching costs were not predicted by any of the five EF measures. Furthermore, the study did not find a connection between children's everyday language control ability reported by parents and CN in the lab. The results do not fully support the domain-generality account, which would mean that EFs are required for language control in bilingual children. While skill learning presumes that associations are more likely in children, given the relatively limited bilingual experience expected at a young age, it does not specify how much bilingual experience would be sufficient for this behavior to rely less on EFs. It is worth considering whether the bilingual children in this study, who acquired both languages from birth, can, in fact, be considered inexperienced bilinguals, and – a more fundamental question – how much experienced is necessary for automatization of cognitive behaviors like language switching. The study's results regarding everyday language control ability do not fully support either account, as the domain-generality account expects certain transfer effect of skills, that is, speakers who are better at switching should have better executive control. According to skill learning, tasks and behavior of the same nature should be associated, which is not supported by the lack of associations between everyday switching and language switching measured in the lab via the CN task. Overall, the study nevertheless adds to a limited body of research on the potential link between children's language switching and EFs and provides insight into the complexities of this relationship.

4.2.1 Comments to Study II

This study adds to a very limited literature investigating the role of EFs in children's language control. The larger domain-generality account, the Inhibitory Control model and the Adaptive

Control Hypothesis are all designed to explain the role of executive functions in adults' bilingual language control, thus they make predictions on speakers who are generally expected to have peaked cognitively. While the main theoretical constructs posed by these hypotheses should be generalizable, making predictions about children's EFs engagement in language control is somewhat more difficult. The children in this study are aged 5-7 and their EFs are still undergoing major development. Ultimately, this might affect language switching in a way that current the theories have not considered.

It is also worth mentioning that the different EF tasks also had different response types in the present study: some used a response box, and others collected oral responses. This could have impacted their performance in the tasks that used a response box, since children's motor skills might also influence the speed of their responses, especially in the younger children.

4.3 Study III

This study explored the extent to which EFs are required in language switching in adult bilinguals, and if so, whether associations can be explained by language proficiency and experience. Similarly to Study II, language switching was measured with a CN task, and EFs with a Simon task, tapping into inhibitory control. In order to evaluate the role of language proficiency, bilingual speakers of Finnish (L1) and Swedish (L2) were divided into three groups based on age of acquisition and proficiency in Swedish. The first group was an early bilingual sample that had acquired both languages in early childhood and were balanced in both of them. The second and third group consisted of speakers that had learned Swedish in late childhood or adolescence, but were divided into high- and low-proficiency groups based on their scores in a Swedish vocabulary test. Based on the skill learning hypothesis, we predicted an association between CN switching costs and EFs for those speakers with limited language experience, who are less likely to have automatized this process. In line with the skill learning account's predictions, our results indicated that the Simon task predicted switching costs in the low-proficiency group, but not in the early bilingual or high-proficiency groups. We also observed associations between Simon and CN mixing in the low-proficiency group, but they were in the unexpected direction. We think this result could be driven by participants' considerable improvement in single trials, which might be a result of getting better at naming in this condition as the task progresses, but not in repetition trials to same extent.

However, this negative mixing costs are not in the direction that would be predicted and are therefore difficult to interpret. The results in this study bring an important contribution to the bilingual cognitive advantage debate, as they challenge a necessary premise of this hypothesis: that general executive control is constantly required for bilingual language control in a dual-language context. If this is not true for a substantial proportion of bilinguals, that is, those with a lot of language experience, the assumption that one might be able to train general cognitive control mechanism by means of language switching must be reconsidered as well.

4.3.1 Comments to Study III

Study III used the picture naming paradigm commonly employed in other studies. Most adult studies we have referred to, however, used this task in a controlled lab environment. In contrast, we ran the experiment online. There was a concern from the authors for potential data loss and for the quality of oral responses. However, a recent study (Uittenhove et al., 2023) has shown that there is little concern for the comparability of web experiments and lab experiments. Running the experiment online allowed us to collect a considerable amount of data in a relatively short period of time, which was a necessity after Covid-related delays in lab-based data collection of Study II. While we experienced some data loss due to bugs in the system, this was not a great challenge, considering the high number of participants who were able to participate. Furthermore, the quality of the oral responses proved sufficient for data analysis. During in-lab data collection, however, the experimenter or research assistant usually notes the accuracy of responses during the experiment, which expedites data analysis. While these are usually double-checked post-hoc, the notes taken during the experiment are certainly helpful. During online data collection this is not possible, and a significant amount of time went into checking all audio files for accuracy prior to the analysis. All in all, online data collection proved satisfactory.

5. Discussion and conclusions

In this dissertation, I posed four general research questions. The first question addressed the effects of the Covid-19 pandemic on language use in multilingual families. Questions two and three related to the role of EFs in language control in two different stages of the lifespan. The last

question addressed a more consequential inquiry, which is what the potential benefits of bilingualism are, and what they might be driven by.

In this section, I will discuss the findings relevant to these questions and explain to what extent my individual papers can answer them. The first question is addressed in section 5.1, the second and third questions are answered in sections 5.2 through 5.5. Finally, the last question is addressed in section 5.5. A brief discussion on validity and reliability of measures and concluding remarks are given in sections 5.7 and 5.8, respectively.

5.1 The effect of the Covid-19 pandemic in language use in multilingual families.

Then as soon as we got home, without a second thought, we reverted to the original tongue, which didn't force us to think about words but only things to say and not say – the language that clung to the body.

– Annie Ernaux –

The Years

The first research question posed by this dissertation was framed in relation to multilingual families, and how parents and children use and interact in the various languages present at home and, ultimately, how the pandemic might have influenced them. For children growing up with more than one language, especially if they do so in a community where there is one major societal language, the family environment is the first locus of learning. When the exposure to various languages comes first from the parents or caregivers, their ideologies around language will likely shape language practices in the family for years to come, as well as their children's own linguistic identity. Ultimately, whether a parent decides to foster a supportive multilingual environment for the child, the extent to which they use the home language, whether they decide to flexibly mix languages or have a stricter "one-parent-one-language" practice, or whether they choose to foster activities in the home language outside family, drive how much exposure and use a child might experience in the home language.

The results of Study I show that parental attitudes towards language, and specifically towards multilingualism, have a significant impact on the use of home languages. In line with previous research in FLP (Hollebeke et al., 2020; De Houwer, 2020), our study showed that positive attitudes towards multilingualism were positively associated with use and exposure to the home language. The families in our sample were particularly driven to encourage a variety of activities in the home language, including literacy, online activities, and school, but they were also interested in fostering communication in that language outside the home, particularly with family abroad. This seems to indicate that, for these families, the home language is not just a vehicle for communication with their children, but a fundamental part of their identity which they cherish and wish to nurture. In some cases, maintaining home language communication might simply be rooted in communicative needs if, for instance, the parents are not fluent speakers of the societal language, which the children usually acquire in kindergartens and school. For these families, however, the considerable support of activities in the home language, in and outside the home, says otherwise.

It is not entirely surprising that the families in our sample were likely to support home language use through a variety of activities, given the parents' positive ideologies towards multilingualism. This finding echoes other research on how positive linguistic ideologies and creating strong linguistic bonds in the family can lead to better linguistic outcomes (Tannenbaum & Berkovich, 2005). In our sample of families, the value put upon maintaining a multilingual identity was very compelling. In the same way, these parents thought it was important for their children to develop a positive multilingual identity as well. This interest extended to valuing literacy in their children's other languages too, although we observed some differences as well as discrepancies across different languages. Parents gave great value to Norwegian, the societal language, for doing well at school, as well as to English. However, the importance given to home languages for doing well at school was secondary. Perhaps this can be explained by the fact that children might not directly use their home language *at* school, and therefore, parents do not perceive a direct benefit from the home language for their children's performance in school. It is, however, intriguing that these parents seem to observe a wide range of benefits in their children's use and maintenance of home languages for all other aspects of their children's lives, including fostering literacy in those languages which, whether the parents are aware or not, research has shown how supporting home language literacy is beneficial for literacy in the society language (e.g., Quiroz et al., 2010). This somewhat contradictory result was even more striking in relation to a question about the value of

the home language for their children's future careers. This question indicated that parents viewed home languages as a gateway for improved career opportunities, but they did not necessarily view school as the place to cultivate those skills. To view language as a form of capital is a common perception of multilingualism in today's society and speaking *certain* languages can promote access to cultural, social and financial capital, what Barakos & Selleck (2019) have referred to as *elite multilingualism.* However, it is important to highlight the high SES of these families, and the fact that Indo-European languages were vastly represented, which could certainly influence the parents' view on their children's multilingualism as a benefit for their future careers. While in our societies speaking English, German, French or even Spanish may translate into social and financial access, being able to communicate in other minoritized languages is not necessarily perceived in the same way.

While some of the questions in the survey reflected parents' overall multilingual ideologies and practices, a crucial goal of the study was to frame those in the context of the pandemic, and how such a significant historical event could have impacted these aspects. The study indeed showed that this major event, which had direct effects on the lives of families and individuals across the globe, also impacted multilingual families' language use. The results indicated an increase in exposure to and use of home languages. This was largely driven by the government enforced homeschooling, remote work, and social-distancing measures. In Norway, most children attend *barnehage,* or 'kindergarten,' at age 1, and this effectively means that multilingual children spend a significant number of hours of the day in a Norwegian-only speaking environment. Research in heritage language development indicates that the first few years of life are often characterized by great exposure in the home/heritage language for multilingual children because they spend a significant amount of time in close interaction with the parents, who are often the main sources of home language input. Once they start school, exposure to the home languages naturally reduces, and children experience growing exposure to, and use of, the society language. In Norway, however, this shift might happen even earlier, given that the state provides free childcare, and most families choose to use this option for an early return to work. Therefore, it is logical that a disruption in these routines might initiate a change in their family language dynamics. For many multilingual families, the pandemic resulted in a direct increase of time at home, and therefore, more opportunities to interact in the home languages. For some families, however, this also meant a challenge to use Norwegian, if this was not a language present in the home.

The degree and intensity of these effects is something that goes beyond the scope of the study. It is not possible to predict whether any positive effects, by means of increased use of home languages, did or will remain in the aftermath of the pandemic. An important outcome of this study was the families' take on multilingualism as a source of well-being in their families, a question for which families expressed a great deal of agreement. Other research has shown how these positive associations towards multilingualism have an overall positive effect on language use across the lifespan, and are a source of connection in the family. With that in mind, I believe that Study I can provide an example of multilingualism as a source of resilience in times of hardship.

5.2 Executive functions and language switching in childhood

The second question posed by this dissertation focused on whether language switching in children is associated with domain-general executive control. This question tackled three important issues. First, the goal was to understand language control mechanisms in children, who are not only still developing their linguistic skills, but whose cognition is still undergoing major developmental changes as well. Most of what is known about language control has been researched in adults, and while there is some evidence that executive control is required to some degree for language control, little is known about how these mechanisms operate in children's minds. Second, there was a question of whether language practices between parents and children, indexed by parents' encouragement to not mix languages and children's ability to stick to those cognitive demands place upon them – what we have referred to as children's everyday language control ability – are associated with children's language control in the lab. Third, the aim was to investigate a more substantial theoretical question: the presumption that general cognitive control mechanisms are, in fact, required for language control.

Our results revealed that the associations between cued naming and EF measures were not consistent enough to assume that language control in children requires EFs. Our conclusions were driven specifically by the lack of significant associations with switching costs in cued naming and EF measures, which were indexes for reactive inhibition and shifting capacity. While some associations were found for mixing costs in cued naming, and these are interpreted as a measure for monitoring, the effects were not found consistently across all inhibition or shifting tasks. Out of the studies examining language switching in children, very few use a cued naming-like-

paradigm, while others tested EFs, but measured switching by means of surveys or play sessions. To our knowledge, only Kubota et al. (2020) measured cued naming in the lab while also using measures for EF control in a group of 7–13-year-old children. Our findings contradict Kubota's findings, who reported a positive association between executive control and language control. In their two-wave study, children's development of executive control predicted children's improvement in language control. Our results also indicated that overall switching and mixing costs improved with age, that is, older children showed smaller switching and mixing costs as compared to younger children, but the lack of an interaction with EF measures does not allow us to establish comparable conclusions with Kubota et al. (2020).

The findings regarding children's everyday language control ability were not aligned with our expectations. Following the AC hypothesis, we selected the families that reported creating a dual-language context at home, and of those, investigated the child's ability to follow the demands of the stricter parent. The statistical models indicated neither a significant association between children's everyday language control ability and their language control in the lab, nor with their EF performance. In Study II we argue that the reduced number of families that composed the "stricter-family" sample, which was only 18, might have decreased our statistical power and, consequently, our ability to find an association across these variables. However, we can only establish conclusions based on the evidence we do have, and that evidence is not in favor of associations between everyday language control and language control in the lab. The question remains as to whether a lab-controlled environment such as the cued naming paradigm is an ecologically valid measure to assess language control, given the circumstances around testing, which may, in fact, eliminate important nuances of switching in a naturalistic environment. Some research has pointed at how lab-testing may prompt switching costs that would not occur in an environment natural to the speaker (see, e.g., Blanco-Elorrieta & Pylkkänen, 2018; Zhu et al., 2022).

In view of the two main questions posed in Study II, the results do not show consistent evidence that language control in children would be governed by general executive control. Moreover, our findings do not indicate that everyday language control ability is associated with cued naming in the lab, or with EF performance. This lack of associations ultimately questions the assumptions of the domain-generality account (Green, 1998; Green & Abutalebi, 2013), which has been widely

accepted in the field in the exploration of bilingual behaviors, such as language switching. This theoretical account assumes that domain-general control cognitive processes have an important role in bilingual language processing. This assumption is not exclusive to understanding language-related behaviors, but it is used to explain how humans operate in a variety of non-linguistic tasks. A potential limitation of this account is whether the relationship between executive control and language control is static, or whether it is affected by the contexts in which a speaker uses their languages. This is specifically addressed by Green & Abutalebi's (2013) AC hypothesis, arguing that dual-language contexts involve a number of control processes (cf. section 2.3) that make it more cognitively demanding than other contexts that allow for greater switching flexibility. Yet, factors such as language experience, changes in the context of use, number of languages, and individual characteristics of speakers do not have an explicit role in the domain-generality account. For instance, this account does not make specific predictions about whether these language control mechanisms act similarly in adults or children. It is perhaps those factors not addressed in this account that may explain why EFs are found to be associated with language switching in some studies, but not in others (Lehtonen et al., 2023). All in all, the fact that associations between EFs and language control are not found consistently across populations of adults and children, poses the very important question as to whether the domain-generality account can sufficiently and systematically explain bilingual language control.

5.3 Executive functions and language switching in adults

The third study of this dissertation further explored the question of whether EFs are required for language control in adults, and how such a relationship might be modulated by language proficiency and bilingual experience. The basis of this question is rooted in the lack of consistent results in the literature in switching in adults and its presumed association with executive control. Given recent theories that bring forward the role of experience and automatization of certain cognitive behaviors (e.g., Paap, 2018 for the Controlled Dose Hypothesis; Jylkkä, 2018; Jylkkä et al., 2021; Lehtonen et al., 2023 for the skill learning hypothesis), we predicted that bilinguals with higher proficiency and greater bilingual experience should show no associations between language switching and EFs, in contrast to less experienced bilinguals, such as speakers in the early stages of learning, who should still show more robust EF-language switching associations. Just as with

Study II, we also posed a more substantial theoretical question: whether the domain-generality hypothesis can explain language control in bilinguals. The relationship between EF control and Swedish proficiency was first analyzed in relation to cued naming performance for the entire sample of bilinguals. Because this revealed a trend for an interaction between switching costs and Swedish proficiency, we considered whether age of acquisition might play a role in participants' experience with Swedish. Thus, we excluded those speakers who had learned Swedish in early childhood, and whom we referred to as early bilinguals, and further explored the same question in the late-learner sample only. This analysis also revealed significant associations between EF and switching costs and Swedish proficiency. We thus decided to divide the full sample into three groups based on their Swedish proficiency scores and their age of acquisition. This provided us with three groups: the early bilinguals, and two groups of late-learners speakers who had acquired Swedish in adolescence and were divided into a high- and low-proficiency groups based on their Swedish vocabulary scores.

The results of Study III provide evidence in support of the skill learning hypothesis, and in opposition to domain-generality. Our findings indicate that not all bilinguals engage EFs for language control: only Swedish learners with lower proficiency showed associations between EFs and switching costs. If we interpret this result in view of the skill learning hypothesis, one could expect that the group for whom switching costs are driven by EFs have neither had enough experience in Swedish, nor with language switching, for it to become an automatized behavior. In contrast, the early bilingual and high-proficiency groups seem to have substantial language experience, giving them the opportunity for this behavior to become automatized, and therefore rely less on EFs.

The findings of Study III, however, unveil a subsequent question: the exact degree of language experience required for speakers to no longer engage EFs during language switching. The skill learning hypothesis (Lehtonen et al., 2023) does not provide specific indications as to how much experience is "enough" experience, and neither did we in our predictions. A further question is whether experience should be accounted for in terms of proficiency, or cumulative length of experience, or both. A point of consideration in view of the results is the methodological decisions to divide the sample in three groups, and how that may affect the results. For instance, the early bilingual and high-proficiency groups resembled each other in the high vocabulary scores and self-

reported proficiency. In this sense, the main factor in which the two groups differed was age of acquisition. The early bilingual group not only acquired both languages from birth or early childhood, they also did so simultaneously. In contrast, the high-proficiency group learned Swedish later in life and has had less cumulative length of exposure in the language. However, both groups showed equivalent results. In contrast, the low-proficiency group started acquiring Swedish at roughly the similar age as the high-proficiency group but had significantly less knowledge in the language. Still, all three groups had had over a decade of experience with Swedish since the onset of learning. Given the results, it seems that proficiency might be a more determinant factor than age of acquisition driving the relationship between EFs and language control.

A further point of discussion is whether the daily use of the two languages, e.g., the contexts of use, the amount of experience with language switching, and the extent to which the use of the two languages has remained similar throughout their lives, influences the relationship between language control and executive control. Information on contexts of use and intentional and unintentional switching was collected in Study III, but the data is too limited to drive strong conclusions. The background information seems to indicate that the early bilingual group used both languages more on a day-to-day basis, with a wider range of speakers and engaged in more intentional switches. While the high-proficiency group resembled the early bilinguals in this respect, the overall use of both languages was less frequent, and they engaged in less switching overall. The low-proficiency group differed from the other two in less overall use of the languages daily, and less switching as well. While these measures are more subjective than language proficiency scores from the vocabulary test, they seem to converge in one way: the early bilinguals and high-proficiency groups have more bilingual knowledge and experience overall, and this alone could be interpreted as sufficient experience for language switching to become an automatized behavior that no longer relies on EFs. However, it is important to consider that "enough experience" might not look the same for different speakers, and that a certain degree of individual variation may exist across speakers, even when their language experience is comparable.

5.4 The role of bilingual experience and language proficiency

In sum, Studies II and III provide a unifying result: EFs may not be required for language switching for all bilinguals. In fact, given that neither children nor adult bilinguals with different ages of acquisition showed associations between EFs and language control, unless the proficiency was low, it seems that this association might actually be restricted to a limited type of bilinguals. Although there might be other factors at play, our findings point to Swedish proficiency and overall language experience as determinant aspects that drive language switching to be dependent on executive control. While the predictions initially made for the skill learning hypothesis (Lehtonen et al., 2023) suggest that children might be more likely to show associations between language control and EFs, our study did not support this idea. However, as is argued in the discussion of Study II, the sample of children tested, who grew up with two languages from birth and had 5 to 7 years of bilingual language use, might have had sufficient experience with language switching to not require general executive control. Reflecting on the types of bilinguals who participated in Studies II and III, it is possible to establish some resemblances between some of the groups. This is the case for the child bilinguals and the group of early bilinguals in Study III. If we focus on the Finnish-Swedish speaking sample, the adult bilinguals in the third study are arguably the future bilinguals of Study II. The language pair and location (the city of Turku) are the same, and the context and social factors are comparable. As with the child sample, the adult bilinguals had largely one Swedish-speaking and one Finnish-speaking parent, both languages were acquired from birth, and were used regularly on a daily basis. These similarities might play a role in the comparability of results: switching costs were not associated with EFs for either the children or the adults. While mixing costs were found to be associated with some of the EFs measures (Cf. section 4.2; Flanker and CS switching) in the child sample, they were not consistently found across tasks. While multiple EF measures were used in the child study, as opposed to the unique Simon task in the adult study, the results are still convergent between the two samples. The similarity in this finding brings us back to the question of how much experience may be necessary for language switching to become automatized and be less dependent of EFs, given that children are still developing with respect to language and cognition. While it is not possible to draw definite conclusions based on our data, this result might give us a hint that automaticity for language switching might actually take place rather rapidly, at least under certain conditions, such as early age of acquisition and frequent and sustained use of the two languages.

By and large, what Studies II and III show is evidence in opposition to the domain-generality account, and generally, in line with skill learning. The contrasting evidence with domain-generality has further ramifications than knowledge about the role, or lack thereof, of executive control in language switching. Ultimately, the lack of evidence in support of the domain-generality hypothesis challenges an important question in the psycholinguistic field of bilingualism, that is, whether bilinguals can benefit from cognitive training by means of language switching. This has been a robust claim for nearly twenty years (e. g., Bialystok, 2017; Bialystok & Craik, 2022), and a considerable debate in the field for at least the last five years (see de Bruin et al., 2015; Paap & Greenberg, 2013; Paap, 2022; Lehtonen et al., 2018). The bilingual cognitive advantage claim resides in the idea that, because bilinguals engage general executive control mechanisms, largely in regard to executive functions, they could train them through language switching. The conflicting evidence on this matter, with some studies showing associations between EFs and language control, and other showing the absence of it, and the recent accounts explaining why an assuming EF control for language switching might be unfitting (Paap, 2018; Lehtonen et al., 2023), directly challenges the domain generality hypothesis and, by extension, the cognitive training hypothesis. The bilingual cognitive advantage debate has offered us the opportunity to reflect on what we do and do not know about bilingual language processing, and we should use this opportunity to deepen our understanding of bilingualism and cognition beyond the scope of executive functions, and putative training effects.

5.5 The environment matters, but how much?

The motivation behind Study I rested on the idea that environment and social factors surrounding multilingual development influence language use. In that study, we aimed to zoom out and explore a number of factors that influence language use in multilingual families, and we included as much linguistic diversity in our sample (45 languages were represented, cf. Section 3.1) as possible. The study findings confirmed that the linguistic ideologies of parents are associated with the language practices and policies enacted at home, and ultimately, impact language exposure and use in children and, arguably, shape the children's future identity as multilingual speakers. Nonetheless, the role of these factors' influence on language use was not explored in isolation, but in the context of a global pandemic. The Covid-19 health crisis, and the subsequent policies and restrictions on

mobility and interaction imposed by governments across the world, created a unique scenario that influence social interaction at all levels, and no less, language interaction. The results of Study I are a good example of major changes in society influencing the linguistic ecosystem of multilingual families. In our study, these changes meant an increased exposure to and use of the home languages, but also a reduction in the number of speakers with whom to use the home languages. For instance, families who would otherwise visit relatives abroad, giving their children the opportunity to use the language beyond the family home, were not able to do so for a significant period of time. While the impact of the pandemic seemed rather positive for the language use of the majority of the families in our sample, what is undoubtable is that it *had* an impact.

Given this result in Study I, we were interested in exploring to what extent there might be associations between more environmental aspects of language switching, such as language practices at home, and children's switching performance in the lab. We thus collected data on language practices between parents and children to create a variable that would represent children's everyday language control ability, and assess whether any associations existed between that and cued naming and EF performance in the lab. The sample of families that participated in this second study varied considerably in the language practices they chose to establish with their children: some families mixed languages freely when speaking with their children and allowed their children to communicate in their language of preference, whereas others established more restricted behaviors around switching. This was the case of the families that we selected to run the analysis exploring the relationship between everyday language control ability and language control in the lab, which revealed no significant associations between the two. While we could observe some patterns in the data for how much children switched languages with their parents – e.g., children whose parents were stricter around switching mixed languages less frequently – this was neither associated with their performance in the language switching task, nor with their EF performance. In Study III, the exploration of speakers' everyday switching behavior was more superficial than for Study II. The division of groups in Study III did inform us that the early bilingual group engaged in more intentional switches than the other two groups, but we do not have specific information about the contexts and speakers in which they switch. Therefore, this measure only informs of the possibility that they might use both languages more regularly than the other groups, which is compatible with their high scores in the Swedish vocabulary assessment, and their self-reported proficiency in both languages.

With this result in mind, it is worth considering that how environment and social factors in general influence language use – and language switching – may not be a straightforward relationship. While environmental factors undoubtedly play a role in language interaction and language use, as Study I indicates, the magnitude of these effects may not be the same across different aspects of language use. Furthermore, the significance of the factors may be relevant to consider. A considerable social change like the pandemic may be drastic enough to drive changes in overall language use, but other environmental factors may not directly influence cognitive mechanisms of language processing. Furthermore, whether different environmental factors initiate a change that may influence language use in the long term is a question that cannot be answered with the evidence presented in this thesis, but is a question worth rising. Ultimately, more research would be required to understand how language attitudes and ideologies would play a role in language switching behaviors in both Studies II and III, which not only collected data in different countries, but on different language pairs.

5.6 Why the benefits of bilingualism might not be cognitive

A focus point in the study of bilingualism has been the question as to whether the ability to speak more than one language poses any kind of general cognitive enhancement, specifically in the area of executive functions. After twenty years of researching this question, the evidence in support of this claim is conflicting, with some studies providing supporting evidence (Bialystok, 2017; Bialystok & Craik, 2022; Declerck et al., 2017; Declerck et al., 2021; Linck et al., 2012) and others, including a number of systematic reviews and meta-analyses, contrasting evidence (Bruin et al., 2015; Donnelly, et al., 2019; Gunnerud et al., 2020; Lehtonen et al., 2018; Lowe et al., 2021; Monnier et al., 2022; Paap et al., 2013; 2018).

The hypothesis that bilinguals could experience cognitive benefits has had a number of ramifications for both science and society in the last two decades. First, it has shifted the scientific view that bilingualism may cause retardation (Goodenough, 1926) to the prospect that the knowledge of multiple languages could, in fact, be beneficial for speakers (Bialystok et al., 2012). The bilingual advantage claim has had significant media coverage in the past decade despite the literature challenging this hypothesis. While no one can deny that being able to speak more than one language has advantageous outcomes, such as the ability to communicate with people of

different cultures, countries, or communities, and satisfies an undeniable necessity to connect with one's own culture and heritage, especially when life circumstances lead to living in a country different to the one considered "home," the reasons to pursue and protect multilingualism should not be tainted. Considering that most people in the world are *de facto* multilingual (Grosjean, 2010), our focus should not be solely on training effects of executive functions, but in understanding the various aspects of multilingualism.

I would argue that one of the repercussions of the discussion of the bilingual cognitive advantage is that it has distracted the conversation from reflecting on a multitude of evidence that shows many other beneficial aspects of speaking more than one language. Some of them are related to cognition and some of them are not. Among cognitive aspects, some evidence has suggested that early experience with more than one language could prompt premature development of Theory of Mind: the ability to take another person's perspective (Chan, 2004; Kovács, 2009), which starts to develop around age 4, and continues throughout the school years. Building on this ability to take another's perspective, older children learn perspective taking, which relates to the capacity to infer the beliefs of others and supports the skill to argue and discuss. Bilinguals have also shown to benefit from this perspective taking in academic writing (Hsin & Snow, 2009). Other research has reported the benefits of convergent thinking, or the process to search the commonality among concepts that appear to be different in principle, in connection to bilinguals' creativity (Hommel et al., 2011).

In the language domain, there are examples of bilingual children benefiting from cross-linguistic influence, such as the case of Dutch-Greek bilinguals, whose familiarity with a morphologically transparent determinant gender-based system in Greek accelerated the acquisition of a non-transparent determinant system in Dutch, offering bilingual children in these languages early acquisition of this morpho-syntactic phenomenon compared to monolingual peers (Egger et al., 2018). Among non-cognitive beneficial outcomes of bilingualism is the economic value, where it has been argued that bilingual literacy can lead to a state's financial benefit (Gándara, 2018), as well as favoring bilingual individuals' access to higher education and increased future earnings (Agirdag, 2014), much as the parents of multilingual children in Study I indicated. Other benefits of multilingualism already mentioned in earlier sections are the ability to create emotional distancing in psychotherapy sessions by using a second language (Dewaele & Costa, 2013), as

well as developing a resilient multilingual identity (Hollebeke et al., 2020) and, ultimately, as Study I has shown, to be a source of well-being in a time as challenging as the Covid-19 pandemic.

All in all, the favorable outcomes of using or speaking more than one language are many, and we might be unaware of other positive aspects that have not yet been studied. Our task as language researchers and multilingual speakers is to continue the quest of understanding the multilingual experience, and its effects, with a broad perspective and open mindset.

5.7 Methodological considerations – Reliability and validity

Skepticism has its place. Statisticians are paid to be skeptics;
they are the conscience of science.

– Judea Pearl & Dana Mackenzie –

The Book of Why: The New Science of Cause and Effect

An important point of consideration in the research of bilingualism and cognition is the lack of replicability of crucial findings and effects, often influenced by small effect sizes and limited statistical power (Byers-Heinleim et al., 2022). Sometimes the lack of replicability is rooted in other factors. One example is the lack of consistency in studies focusing on the bilingual advantage. While the lack of consistent associations might be related to our limited ability to understand bilingual behavior under the current theories, as it has repeatedly been suggested in this dissertation, some research has argued that the reason behind these positive associations might be caused by inconsistent research practices and publication bias (see e.g., de Bruin et al., 2015). This dissertation is not focused on the bilingual advantage per se, but as we have previously argued, Study II and III have consequences for this line of research. Maintaining valid and reliable science is not only about using reliable methodologies, but also being open to refute and revise our hypotheses when the data goes against them. Scientists, like other humans, hold a certain level of bias and subjectivity, and we need remain aware of when that interferes with our research.

A point of reflection is the validity of cross-linguistic proficiency measures in bilingualism studies. Sometimes this is caused by adapting a measure into other languages that has not actually been validated in the original language. Other times, the standardization of measures across languages

is not fully equivalent across cultures. In Study II, we used the Cross-linguistic lexical tasks to measure children's proficiency across language pairs. While we used tests that were supposed to be standardized across all four languages used (Norwegian, Spanish, Finnish, and Swedish), it might not be completely possible to equate them in all languages. On occasion, some cultural norms might apply. For instance, we noticed that some of the tests had a significant gender bias. Such was the case for Spanish, in which activities such as cleaning and cooking were exclusively performed by women, and others, such as wood cutting, by men. While the researchers' intention might have been to accurately represent the reality that children might be exposed to in their immediate environments, as scientists and researchers, we have a solemn responsibility to pursue and protect the quest for knowledge, and to defy and confront all forms of information that are not evidence-based, and that ultimately threaten the right and liberty to access equal opportunities and exist in our society.

It is relevant to bring attention to the ecological validity of measuring cued naming in the lab. While cued picture naming is a widely used task to measure language switching in a lab-controlled environment, one can ask whether it adequately reflects everyday language switching, even in a dual-language context. Some studies (Blanco-Elorrieta & Pylkkänen, 2018; Zhu et al., 2022) have argued that some switching and mixing costs might arise from the pressure of a highly controlled environment that eradicates the natural conditions of everyday language switching. As we argue in Study II, the lack of associations between cued naming and everyday language control ability could have been driven by a lack of validity of the lab switching task, or by the parents' subjectively reported switching behaviors in the family.

5.8 Concluding remarks

This dissertation explored the degree to which environmental and cognitive factors may impact bilingual language use and language switching at different stages of the lifespan using a combination of methodologies and theoretical frameworks.

One of the key factors investigated in the dissertation is the multilingual environment in which bilingual individuals are raised during their early years. These formative years are influenced by the parents' and caregivers' language ideologies and practices, which ultimately shape language policy at the family level. However, external forces in society can affect families' language

practices and policy. Here, I have argued how the Covid-19 pandemic acted as an external force that ultimately influenced language exposure and use in a sample of multilingual families in Norway. My arguments are supported by the data in parents' reported increased exposure to the home languages. For families for whom Norwegian was not a home language, this also meant a disruption in their exposure to Norwegian, for both families and children. The data also provides relevant insights as to how these participants considered multilingualism as a source of well-being in their families, and how this might have been a source of resilience in an otherwise very challenging situation. All in all, the results of Study I suggest that the pandemic provided challenges as well as opportunities for language use in multilingual families. This historical event also provided an opportunity to study multilingualism in rare circumstances.

The second contribution of this dissertation is the question of whether domain-general cognitive control mechanisms, and more specifically, executive functions, are required for language control in bilingual children. While there is some evidence that children might engage executive functions in bilingual language control, the results of Study II did not reveal consistent associations between the two. This evidence neither aligns with the limited research in bilingual children, nor with the domain-generality account, which expects EF-language switching associations in children. Furthermore, the study revealed no associations between children's everyday language control ability and language switching and EF performance in the lab.

The question of whether executive functions are required for bilingual language control was further explored in a group of Finnish-speaking adults with various degrees of Swedish language proficiency. Here, I posed the question as to whether associations between executive functions and language control are modulated by language proficiency and prolonged bilingual experience. The sample was divided into three groups of early bilinguals, and late-learners with high and low proficiency in Swedish. Associations between switching costs in the cued naming task and executive functions were found only for the late-learner group with lower proficiency in Swedish. This result challenges the domain-generality hypothesis where executive functions are presumably engaged in language control for all bilinguals and provides support for one of the core aspects of the skill learning account. That is, that prolonged bilingual experience and language proficiency might support the automatization of bilingual behaviors like language switching, and ultimately rely less on executive control.

By employing a combination of methodologies and theoretical approaches, this dissertation supports the view that language use in bilingual individuals is shaped by environmental and cognitive factors. The findings contribute to our understanding of the complex dynamics of bilingual language use, and offer insights into how language development and language switching can be influenced throughout different stages of the lifespan.

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Part II
Articles

Article I

Language brings with it an identity and a culture, or at least the perception of it. A shared language says "We're the same". A language barrier says "We're different".

– Trevor Noah –

Born a Crime: Stories from a South African Childhood

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Elisabet García González*, Liquan Liu and Elizabeth Lanza

Language in multilingual families during the COVID-19 pandemic in Norway: a survey of challenges and opportunities

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Abstract: The first lockdown of the Covid-19 pandemic resulted in school closures and homeschooling for families across the world. This provided a unique scenario to investigate multilingual family language interaction, and specifically, challenges and opportunities for home language (HL) use. This study is rooted in Family Language Policy (FLP) research, building on previous models of language policy as language beliefs, practices and management, as it addresses the effects of the lockdown on the use of, and exposure to, HLs. An online survey was used to assess the language beliefs, practices and management in a sample of families in Norway, a country with a significant and complex linguistic diversity. Our results indicate overall positive attitudes towards multilingualism in Norway, which are associated with an increased use of, and exposure to, Norwegian and HLs during the lockdown. Furthermore, we find a unique presence of English in multilingual families in Norway, especially across online spaces. Lastly, our study shows that the perception of multilingualism as a source of well-being is associated with positive effects of the lockdown in the use of HLs during the pandemic. We contend that this result can be taken as an example that, even in dire times of despair, families can find opportunities to promote multilingualism and language maintenance.

Keywords: Covid-19 pandemic; Family Language Policy; language maintenance; multilingualism; well-being

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1 Introduction

The ongoing global pandemic of Covid-19 has caused a major impact on all aspects of human interaction, including family language communication and children's overall language development. In this respect, multilingual families have experienced a unique change in their daily dynamics due to school closures, home confinements, homeschooling, and the impossibility to travel for extensive periods of time. This situation created a once-in-a-lifetime scenario to study the challenges and opportunities multilingual families faced during the pandemic. In an increasingly globalized world with mounting migration across borders, children growing up with more than one language have become a rather frequent phenomenon (Lanza and Lexander 2019). Nonetheless, multilingual families are heterogeneous and so are their family language dynamics. Moreover, the political, demographic, and socio-cultural factors around children growing up multilingual can be radically different depending on the country, the linguistic diversity, and the socio-cognitive environment. While these factors pertain to the general field of Language Policy, family language interaction not only concerns language policy but also child language acquisition, upon which the field of Family Language Policy (FLP) was originally founded (King et al. 2008).

FLP brings together the study of language acquisition and language policy by focusing on the social environments and caretakers' ideologies and decision-making strategies that influence children's developmental trajectories and, in connection with formal schooling, impact their future use of, and relation to, minority and home languages (HL), including the development of literacy skills (Curdt-Christiansen 2018; King et al. 2008). In spite of the extensive research on language socialization in children, the perspective on the family as a social nucleus under FLP has only gained focus in the last ten years, most likely due to increased transnational mobility in Europe and North America, which has drawn attention to multilingualism worldwide (Wright and Higgins 2022). These new waves of international mobility are precisely what may have shifted the tradition of studying multilingual language acquisition from a comparative approach with monolinguals, as noted in Serratrice (2019), to focusing on the diversity of factors that influence the multilingual experience as a whole (De Houwer 2022; Lanza and Lomeu Gomes 2020; Schalley and Eisenschlas 2020). Here, FLP can offer a more holistic approach to the study of child language development.

The three components of FLP, deeply rooted in Spolsky's (2004) tripartite model of language policy, are language beliefs, language practices, and language management. *Language beliefs* refer to the attitudes and ideologies surrounding a language or languages in the family and community. Accordingly, Sevinç (2016) showed that HL identity decreases across generations, with first-generation immigrants more

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likely feeling stronger linguistic identity through their language, which decreases in second and third generation immigrants. In addition, multilingual speakers with immigrant backgrounds can experience language anxiety, which ultimately affects language maintenance over time (Sevinç and Dewaele 2018). While positive or negative linguistic attitudes towards multilingualism may be related to family socio-economic status (SES), an environment that fosters positive views towards multilingualism might promote language use and maintenance. This is not only in the case for spoken language, as attitudes towards early bilingualism in the family have been found to have a major impact on the development of literacy in the HL as well (Kang 2015). Moreover, societal language ideologies play a role, with a hierarchy of languages at play in each society, often with English at the top. *Language practices* comprise the choices caretakers make about language use in their family. Some may choose to follow a One-Person-One-Language (OPOL) strategy (Ronjat 1913), whereas others may switch languages in their daily conversation (Lanza 2004). Although these practices done regularly could be construed as policy, observation data on parental language practices indicate that parents who claim this policy do not always maintain it and rather switch between languages. Lastly, *language management*, or planning, according to Spolsky (2004), referred to the impact of individuals' or groups' actions that influence language beliefs and practices, and ultimately, possible changes in linguistic behavior. When it comes to family language management, such actions might come indirectly or directly. For instance, a caretaker might choose not to respond to their child if they choose the "incorrect" or unexpected language, to which the child might infer the need to switch languages to continue communication. In other cases, caretakers might offer more direct forms of reward or sanction. More recently, Spolsky (2019: 323) called for a modified and enriched theory of language policy (and management), in which he posits that language policy "may be blocked or hampered by non-linguistic forces such as genocide, conquest, colonization, introduced diseases, slavery, corruption and natural disasters". Covid-19 was indeed such a drastic non-linguistic force that had an impact on personal language management in the home. Spolsky's model is widely accepted in the field of FLP, although several authors point at more holistic views that interpret all three constructs as a continuum where such policies depend on explicit as well as implicit choices (Caldas 2012; Slavkov 2017). Indeed, in line with current approaches to the study of language policy, implicit and patterned language practices across time can form *de facto* language policies, also in the home.

While language beliefs, practices and management are crucial to understanding the environment surrounding the child's language development, children's ability to communicate, read and write in the parents' or caretakers' language(s) is highly dependent on their access to input in the minority HL. The amount and variety of the input, such as the diversity of speakers and contexts in which the HL is used, plays an

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important role in language development (Unsworth 2016). Subsequently, the more types and sources of input in the HL, the greater the chances of a richer multilingual experience. Often, the only source of input is from the caretaker(s), and a more diverse community of speakers is not always readily available to the child. In this respect, children's only chance to secure diverse sources of input is family abroad.

Socio-affective factors are also crucial for children's language development. In their systematic review, Hollebeke et al. (2020) report a number of studies that relate socio-emotional well-being to FLP (cf. De Houwer 2020). Positive or negative emotions towards the HL are heavily associated with linguistic outcomes: "Linguistic well-being, on the one hand, refers to positive or negative emotions related to language acquisition, proficiency, use, etc. (e.g., parental frustration due to a child's low home language (HL) proficiency or reluctant HL use). Socioemotional well-being, on the other hand, involves family relations, identity, general feelings of well-being, etc." (Hollebeke et al. 2020: 4). When families are able to create a solid emotional connection to the HL and culture, they might create stronger family cohesion (Tannenbaum and Berkovich 2005), which potentially may lead to more use and higher proficiency in the HL (Hollebeke et al. 2020).

Considering the effects of the Covid-19 pandemic on multilingual families, some questions must be addressed. As we have discussed, growing up in multilingual households is greatly influenced by the language beliefs and attitudes around the child (whether positive or negative), the language practices at home (e.g., input and environment provided by the caretakers), and the language management, for instance, the interventions and initiatives taken to use the HL. These are heavily influenced by the factors and conditions in the surrounding environment, and ultimately, are subject to any major changes that might affect social interaction inside and outside the home (Mirvahedi 2020; Purkarthofer et al. 2021).

The effects of the Covid-19 pandemic, whether positive, negative or neutral, have already been studied across a range of developmental and psychosocial factors. For instance, von Soest et al. (2022) found that gender and SES were predictors for social satisfaction and well-being in adolescents in Norway, where girls and adolescents with lower SES experienced more adverse changes during the pandemic. In a study of English as a Foreign Language in Germany, Hopp and Thoma (2020) found no negative effects of school closures on the foreign language vocabulary or grammar of school age children. Lastly, a study of the stressors of Covid-19 in family life in the United States reported that anxiety and perceived negative effects of the pandemic in the family increased the risk of moderate depression (Crandall et al. 2022). However, participants who expressed more positive associations towards family well-being were less likely to experience depression and anxiety symptoms. It is clear that the effects of the pandemic are various and exist across countries and populations.

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1.1 This study

The Covid-19 pandemic provided a unique scenario that offers multilingual families not only challenges but also opportunities for the use of, in particular, minoritized languages in multilingual families. To address this, research should concentrate on the relationship of the three components of FLP during the lockdown in a specific context. Norway presents an excellent locus for investigating these issues due to the wide language diversity in the country and greater tolerance for linguistic diversity, given its two written norms (Bokmål and Nynorsk) and acceptance of dialects in all situations, both formal and informal. There is, however, some tension when this ideology of acceptance meets diversity from migration, creating disturbances and dilemmas (cf. Røyneland and Lanza 2023). Mother tongue instruction is a good example. Scandinavia has had waves of acceptance and repeal of such instruction across the years (cf. Salö et al. 2018). In Norway, the Education Act currently states that students whose mother tongue is other than Norwegian or Sámi are entitled to special training in Norwegian until they are proficient enough in Norwegian to follow the regular school teaching. If necessary, these students are also entitled to mother tongue teaching. Using the mother tongue is only meant as a transition in schools until the children are able to follow the teaching in accordance with the regular curriculum in Norwegian. As for kindergarten or preschool children, there are some communities that have organized complementary or Saturday instruction in the respective HL.

Multilingual families faced important challenges during the lockdown that might have limited the input in HLs, such as the inability to travel to the home country or attending extracurricular activities in the HL outside the home. However, home office and homeschooling might have provided opportunities for further interaction between caretakers and children in the HL. In this study, we will indicate how the Covid-19 pandemic and subsequent lockdown are associated with each component of FLP, across a variety of families in one country – Norway, with diverse family language constellations. We address the following questions:

1) What are the beliefs about multilingualism in multilingual families in Norway, and how do they shape language practices and management during the lockdown?
2) What are the language practices and activities in the HL and Norwegian before and during the lockdown and social distancing measures?
3) What is the impact of school closures and social distancing measures on children's exposure to, and use of, Norwegian and the HL?

We expected parental beliefs to show associations with language practices and management during the lockdown (i.e., more positive attitudes towards

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multilingualism could lead to more use of the HLs during the pandemic). This should reflect in more time and more activities using the HLs during the lockdown than before, for those families who value multilingualism. Moreover, we anticipated that the closing of schools would contribute to more use of the HL, since many children spent less time than usual in a Norwegian-speaking environment. While case studies may provide in depth understanding of one family, we deemed a questionnaire survey would be able to tap on to the diversity of families and their experiences, and thus provide enough data to observe some statistical tendencies in a population.

2 Methods

2.1 Participants

A total of 193 multilingual families with children in Norway (see Appendix I for geographical distribution) participated in the study. Participants were recruited through social media posts and social networks in public libraries established prior to the pandemic; the survey was available in both Norwegian and English. Of the total sample, 140 families responded to the survey in English and 53 in Norwegian. The final sample consisted of 188 families (*Mean age* of the child = 5.9 years, *SD* = 4.1 years). Data from 5 families were excluded due to children having special learning needs or developmental conditions, including autism, deafness or learning impairment. While these families were indeed of interest, the low number of families reporting special needs, which were varied, made it impossible to make a fair assessment of how families with children with special needs may have been impacted by the pandemic. A total of 45 languages was represented in the data; 56 % of the families used Norwegian at home (in addition to other languages). Language background is summarized in Appendix I. When it comes to the language practices caretakers chose to use with their children, 53 % of the families reported using the OPOL strategy, 30 % reported mixing languages with their children, and the remaining 17 % were a single-language household. The majority of caretakers had higher education (73 % had at least a Master's degree, 23 % had a PhD degree, and the remaining 4 % had a Bachelor's degree or less). The background information allowed us to explore age and the presence of Norwegian at home in our analysis. The data processing plan was assessed by the Norwegian Agency for Shared Services in Education and Research to ensure that data collected in the project was processed in accordance with data protection legislation (reference number 103144), and all participating families consented to their data being used for scientific purposes, prior to the beginning of the survey.

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2.2 Instrument

A survey, *Language in Multilingual Families during the COVID-19 Pandemic in Norway* (see Appendix II), was used for data collection. A dummy version survey can be viewed https://nettskjema.no/a/274750 (in English) and https://nettskjema.no/a/274752 (in Norwegian). The survey was conducted between 18 May 2020 and 30 June 2020, immediately after the first lockdown that affected kindergartens, schools and high schools in Norway (from 12 March 2020 until 11 May 2020, with a gradual opening in late April starting with younger children). While social distancing was highly recommended and some restrictions were set until the end of the school year (for example, the number of people allowed to gather for events), there were no general rules in place concerning quarantine or isolation. Respondents were instructed to answer the survey reflecting on this time period, which captured the original reactions of families in this dramatic change in social life. This, and the unpredictability of the future situation, was the reason why we focused on the *first* lockdown and not on subsequent effects of the pandemic. While schools reopened (on 11 May 2020), restrictions were nonetheless implemented, including smaller groups, physical distancing and partial homeschooling that took place digitally until the end of term of the school year. Like most countries, Norway, and especially the greater Oslo region, maintained social distancing measures and home-office mandates to some degree for much of the pandemic.

The survey is an adapted version of the questionnaire designed for the UK and Ireland by Ludovica Serratrice and colleagues, which had been conducted there prior to the current study, and which we were granted permission to use. Questions were adapted to fit the Norwegian context. The original English survey was translated into Norwegian by a bilingual research assistant and checked by the researchers leading the project. Overall, the translation of the survey did not present any problems. Nonetheless, the direct translation of the term 'well-being' into Norwegian seemed somewhat confusing for a few families who did the survey in Norwegian, as there is no direct equivalent. This is understandable, given that professionals also vary with translations. Notably, a 103-page document published by the Norwegian Directorate of Health (Carlquist 2015) points out that the international literature contains a number of understandings of the concept of well-being while their document discusses how 'well-being' can be useful in a Norwegian public health context. That being said, the term 'well-being' is often used in English in Norway and hence one would be familiar with the general term and potential translations.

In addition to making the survey available in two languages, we adapted the background information section of the original UK/Ireland survey to fit factors

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relevant for Norway. We added specific questions about the use of English, in addition to the questions about Norwegian and other HLs in general. The reason for adding specific questions about English is due to the particular space this language occupies in activities and in the language hierarchy in Norway. Contrary to the UK and Ireland, English is not the main societal language; however, most people are fluent speakers of English, the language is introduced early on in the education system, and it is not uncommon to hear English in social spaces. Moreover, multilingual families in Norway frequently use English at home when, for instance, one caretaker is a Norwegian speaker and the other has a different L1, or as a lingua franca when neither caretaker is a Norwegian speaker. The online survey was established on the University of Oslo's internal data platform Nettskjema. Due to restrictions with this platform, we needed to convert the original response scale of 0–100 in the UK/Ireland survey to a 5-point Likert scale. In order to allow respondents to provide some nuances to their answers, we also included a comment section at the end of the survey. In our survey, participants could choose English or Norwegian language versions of the same survey, although about 70 % of the families responded in English, as noted above.

3 Analyses

The survey consists of three sections related to FLP as well as demographic information described under 2.1. Sections 1–3 examine caretakers' feedback, each targeting one aspect of Spolsky's (2004) model: beliefs, practices and management. To analyze our data, we aggregated related variables to facilitate the statistical analysis. Variables in the three sections are average ratings of questions pertaining to the same category (cf. Appendix II). Below, the aggregate variable is noted in italics, with the survey questions on which it is based indicated in parentheses. In total, there are 14 variables.

3.1 Section 1: Beliefs

The questions in this section include targeted caretakers' beliefs concerning, and attitudes toward, multilingualism, mapped by their (dis)agreeing to statements. Answers were collected on a 5-point Likert scale rating level of importance (not important, slightly important, moderately important, important, and very important). These variables reflect caretakers' identity and beliefs related to aspects of multilingualism, such as maintaining contact with family abroad in the HL or the importance of HLs and OLs (Other languages) for school and future career.

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1. *Identity* = Parent/Caretaker value of their and their child's multilingual identity (Q17, Q18)
2. *HL-Communication* = Value of maintaining regular contact with foreign family and use of the HL (Q19, Q20, Q27)
3. *HL-Schooling* = Value of HL/OL for school (Q23, Q24)
4. *HL-Career* = Value of HL/OL for the child's future career perspectives (Q25)
5. *HL-Literacy* = Value of reading and writing in the HL (Q28, Q29)

3.2 Section 2: Practices

This section gathered information on language use in the family during the lockdown and social distancing measures. Answers were given on a 5-point Likert scale rating the level of frequency of different activities (never, rarely, sometimes, often, very often) and in different languages, such as reading to their children, watching TV, playing computer games, speaking to family abroad on FaceTime, speaking to siblings, and reading and writing for the older children. These variables reflect caretakers' language practices and activities in each language.

6. *Literacy-NOR* = School and literacy practices in Norwegian (Q30, Q32, Q44, Q46)
7. *Literacy-HL* = School and literacy practices in HL/OL (Q31, Q33, Q45, Q47)
8. *Digit-NOR* = TV, videogames, Skype, etc. in Norwegian (Q34, Q37, Q42)
9. *Digit-HL* = TV, videogames, Skype, etc. in HL/OL (Q35, Q36, Q38, Q39, Q43)

3.3 Section 3: Management and impact

This section targets caretakers' perceptions of the impact of school closures and social distancing measures on language use in their families (and in the different languages). Answers were given on a 5-point Likert scale rating level of disagreement (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree) to tap into positive and negative effects in the different languages. We were particularly interested in changes in the use of their languages before and after the lockdown (like reading, writing, recreational activities).

10. *Neg-NOR* = Negative effects of lockdown measures/homeschooling on Norwegian (Q48)
11. *Pos-NOR* = Positive effects of lockdown measures/homeschooling on Norwegian (Q49, Q50)
12. *Pos-HL* = Positive effects of lockdown measures/homeschooling on HL (Q51, Q52, Q53, Q54, Q55, Q61, Q62, Q63)
13. *Hear-HL* = Exposure HL = Question about more input in HL during lockdown (Q61)

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14. *Well-being* = Using other languages is a source of well-being in the family (Q64)

Below, we first present the statistical analyses, and then discuss their interpretation (Section 4). Pearson correlations were conducted in between variables of beliefs (Section 1), practices (Section 2) and management (Section 3). See Section 2.2 to understand the relationship between each FLP component. Below we show descriptive statistics (Table 1), a matrix correlation (Figure 1) and a summary of significant correlations (Table 2).

The means (*M*) and standard deviations (SD) of 188 participants were recorded in the original 5-point Likert scale. In Table 1, aggregate variables from the beliefs section indicate very high ratings with respect to *Identity* ($M = 4.2$), *HL-Communication* ($M = 4.6$) or *HL-Literacy* ($M = 4.3$); all of these variables focused on the importance given by these families to multilingualism in general, and the HLs specifically. While the mean ratings of variables in the practice and management sections lay somewhat in the middle of the scale, they are slightly higher for the variables *Hear-HL* ($M = 3.7$) and *Well-being* ($M = 3.5$), which refer to whether families reported increased exposure to the HL, and whether multilingualism is considered a source of well-being during the pandemic, respectively.

In Table 2, significant correlations ($p < 0.05$) between variables are marked by an asterisk, which are concurrently represented as medium size, darker circles in the heat map (Figure 1). Significant correlations between variables do not imply a causal relationship but signal a trend observed between variables. For instance, the correlation between HL-Communication and HL-Literacy ($r = 0.4$) indicates that families that foster communication in the HL are also more likely to encourage literacy in the HL.

Table 1: Descriptive statistics of aggregate variables, means and standard deviations.

	Variable	*N*	*M*	SD
Section 1	*1. Identity*	188	4.2	0.9
	2. HL-commun	188	4.6	0.9
	3. HL-schooling	188	3.4	1.0
	4. HL-career	188	4.1	1.1
	5. HL-literacy	188	4.3	1.1
Section 2	*6. Literacy-NOR*	188	2.7	1.2
	7. Literacy-HL	188	2.9	0.9
	8. Digit-NOR	188	2.8	1.0
	9. Digit-HL	188	2.9	0.9
Section 3	*10. Neg-NOR*	188	2.2	1.2
	11. Pos-NOR	188	2.3	1.1
	12. Pos-HL	188	3.3	0.9
	13. Hear-HL	188	3.7	1.2
	14. Well-being	188	3.5	0.9

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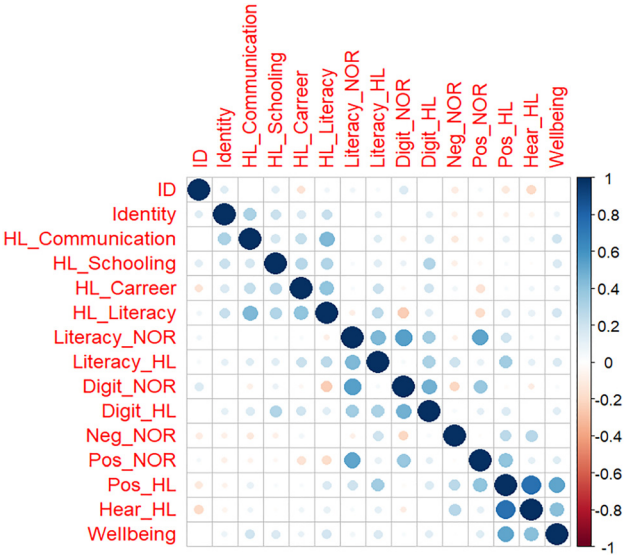

Figure 1: Correlation matrix heat map.

In Figure 1, the left vertical and horizontal axes indicate variables of Beliefs, Practices and Management. The right vertical axis (from –1 to +1) and the circles in the grid (differing in colour and size) indicate the degree of positive (blue) and negative (red) correlations. The larger/darker the dots, the stronger the correlation.

Table 2: Significant positive correlations for the aggregate 14 variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Identity														
2. HL-commun														
3. HL-schooling														
4. HL-career														
5. HL-literacy		0.4*												
6. Literacy-NOR														
7. Literacy-HL						0.4*								
8. Digit-NOR						0.5*								
9. Digit-HL								0.5*						
10. Neg-NOR														
11. Pos-NOR						0.5*								
12. Pos-HL														
13. Hear-HL												0.8**		
14. Well-being												0.5*		

Notes: (*) moderate ≥ 0.4; (**) strong ≥ 0.8. The correlation coefficient measures the size of an effect: values of ±0.1 represent a small effect, ±0.3 is a medium effect and ±0.5 is a large effect (Field et al. 2012: 212).

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Table 3: Estimate coefficients, standard error, *t* distribution and *p*-value for each of the significant predictors in the linear regression models.

	Effect/variable	Predictor	Estimate	SE	*t*	*p*
1	Literacy-HL	HL-communication	0.18	0.09	1.8	=0.07
2	Pos-NOR	Literacy-NOR	0.46	0.05	8.4	<0.001[a]
3	Pos-HL	Literacy-HL	0.34	0.07	4.9	<0.001[a]
4	Well-being	HL-communication	0.26	0.09	2.7	=0.007[b]
5	Pos-HL	Well-being	0.52	0.06	8.3	<0.001[a]

Notes: [a]$p < 0.001$; [b]$p < 0.01$.

Because correlations cannot be interpreted as causal relationships, significantly correlated variables were further analyzed in linear mixed models for regression analyses (Baayen et al. 2008) using R (R core Team 2021) to evaluate the effect of certain predictors. This is summarized in Table 3. The significant predictors in the linear regression models indicate that: 1. Communication using the HL in the family marginally predicts child HL-literacy; 2. Child's Norwegian literacy predicts positive effects of homeschooling on Norwegian during the lockdown; 3. Child's HL literacy predicts positive effects of homeschooling on HL during the lockdown; 4. Communication using the HL predicts family well-being, and 5. Well-being further predicts positive effects of homeschooling on HL during the lockdown.

Unlike the correlation of variables reported above (see Table 2), the results of the linear regression models provide more precise information as to the extent to which the predictor variables can explain the effect variables; for instance, the fact that encouraging more literacy in the HLs can predict a positive effect on the HLs during the pandemic, as the third model in Table 3 indicates. In the following section, we delve into what the statistical analyses, by means of correlations and linear regression models, mean in the further scope of the paper, and the extent to which these results answer our research questions.

4 Discussion

By using a survey to examine multilingual families' language beliefs, practices, and management (Spolsky 2004), significant relationships were observed between variables across the three components. Below, we discuss each of the three components along with its interaction with the others.

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4.1 Language beliefs

In regards to our first research question on the language beliefs of multilingual families in Norway, our results show positive attitudes towards multilingualism in this sample of families, as shown by the high ratings towards multilingualism in the variables reflecting identity and beliefs (cf. Table 1). The reported correlations support the inferences drawn by the data. The fact that caretakers themselves see multilingualism as an important part of their identity may contribute to valuing multilingualism in their children too. Contrary to our expectations, the variable assessing multilingual identity, which included questions regarding caretakers' value of multilingualism, did not deem a significant correlation nor a significant result in the regression analysis with other variables in language practices and management. That means that while these families showed high ratings on the importance of multilingualism for their and their children's identity, the variables targeting these questions did not predict responses on variables about language practices or management. However, other variables of language beliefs did reveal associations across sections. Specifically, caretakers' value of maintaining communication with family members abroad was a predictor of frequent literacy practices in the HL, as well as of families' perception of multilingualism as a source of well-being (see Table 3). Ultimately, our sample revealed that families' overall positive attitudes towards multilingualism were important in maintaining and increasing activities in the HL during the lockdown. The positive attitudes to and around multilingualism might have influenced the overall positive impact of the lockdown, as positive attitudes have shown to be important factors to maintain HL and to promote language learning (Dewaele and MacIntyre 2014). Conversely, negative attitudes and anxiety can in fact lead to less attachment to the HL across generations (Sevinç 2016; Sevinç and Dewaele 2018).

4.2 Language practices

Concerning the question of language practices and activities during the lockdown, our data revealed associations between the use of online platforms in Norwegian and in other languages (see Table 2). We interpret this result as an indication that families that rely on online activities for language use might do so in several languages, which was positive during a time when social interaction outside the home was impossible. An interesting finding is the association of literacy practices in Norwegian and in the HL. Families who are likely to encourage literacy practices in Norwegian also seem to do so in the other HL. This result is supported by the overall caretakers' ratings on the value of reading and writing in the other language. It seems that whether families choose an OPOL strategy, or a more relaxed

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approach to mixing languages (Lanza 2004), promoting the use of HLs through various activities is crucial for language maintenance.

4.3 Language management and impact

When it comes to our third question, the actual impact of school closures and social distancing measures in these multilingual families, we observed an overall trend that spending more time at home with their children meant increased use of, and exposure to, the HL. This finding aligns with Spolsky's (2004, 2009, 2019) interpretation of language management in families, as well as Caldas' (2012) and Slavkov's (2017) more holistic view that includes caretaker's (in)direct actions on language use. In addition, hearing more of the HL during the lockdown was associated with positive effects on the HL as a consequence of the lockdown (cf. Table 2). This result echoes that of recent research showing monolingual infants' larger vocabulary growth during the first lockdown across thirteen different countries (Kartushina et al. 2022). Changes were not only found in the HL, we found an association between the different activities involving Norwegian, such as reading and writing, and a positive effect of the lockdown in Norwegian. In fact, when specifically asked about whether caretakers would like to elaborate on changes in their children's language during the pandemic, several provided valuable information. For instance, one participant reported:

> "My son (…) is a bit behind the level of the class. He really improved his Norwegian reading during the lockdown, since we had more time to individually support him in a positive way. Before he was much more negative."

When we further look at ratings in the individual questions regarding the effects of the lockdown in these families' Norwegian, we observe a discrepancy between families for which Norwegian is a primary language at home, versus families where it is not (cf. Appendix I). For the latter, concern was expressed about negative effects of the lockdown on the use of, and exposure to, Norwegian. For instance, another parent expressed:

> "Our primary exposure to Norwegian language is through work and the *barnehage* ('preschool'). We [use] 100 % spoken English at home. The closures have negatively impacted the entire family's ability to learn and use more Norwegian language."

This is a finding we did not anticipate, as our main focus was on how the pandemic had affected HLs. While they are the minority, for this subgroup of families, going to work and school is effectively the only exposure to Norwegian; it is worth noting that the social distancing measures did not only affect people's ability to socialize but it

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potentially impacted linguistic and cultural access of migrant groups in different countries and thereby their inclusion in society. While this was a concern raised by some respondents when given the possibility to add individual comments, the data revealed that the practice of activities in Norwegian was in fact associated with positive effects in Norwegian, too.

While the survey was designed to look at differences between Norwegian and other minority HLs, we had anticipated that English would have a unique role in multilingual families in Norway and generally in Norwegian society. Most Norwegians are fluent in English from an early age, due to the early introduction of the language in schools, its relevant role in the media, as well as the increasing number of highly skilled workers migrating to the country. In major cities like Oslo, Trondheim or Bergen, it is not uncommon for employees in the service industry to communicate in English (Røyneland 2023), and this language has a big presence in the lives of multilingual families as well. Often, parents who have different linguistic backgrounds use English as a means of communication and, even when they might use their first language with their child, he or she is still highly exposed to English, too. While the role of English was not one of our main questions, our expectations were confirmed by the data, where English has a major presence in online activities. When we split the data across Norwegian, English and other languages, activities like watching TV, playing videogames or using the internet are more likely to occur in English than any other language. This is also confirmed by some caretakers' additional comments:

> "My kids have started using more English in their Norwegian speech with Parent 1 and each other during lockdown, because they are watching more YouTube and playing Minecraft, Animal Crossing and Zelda. Words from the games are difficult to translate into Norwegian."

For some families, the presence of English was directly related to home office and homeschooling, as another participant reports:

> "My children started to be interested and speaking more English during lockdown. Assume this is a result of working from home for international company and them hearing mom use this language. None of the parents are English native speakers but we started to speak English as the kids have shown interest."

For families where English is the HL, this probably means special support in that language. Furthermore, we found results that we had not anticipated regarding the value caretakers placed on different languages. We decided to further investigate the percentage ratings of the value of Norwegian versus other languages for school (questions 22–24 in the survey, see Appendix II), which revealed that caretakers seem to value Norwegian and English for school more so than the other language(s) that might be present at home. This indicates that while caretakers wish for their children

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to use the other languages beyond the home environment, including for their future careers, they consider Norwegian and English as more important for their children to do well in school than other HLs.

Question 57 ("I miss the support of other parents/friends who speak our family's other language(s)") revealed mixed results, based on whether English and/or Norwegian were used at home. About half of the respondents agreed (selected 4 or 5 in the Likert scale) that they missed the support of family members who speak their language, whereas the other half was divided between rates 1–3. This question generated variation in responses among the families that had Norwegian at home, the families for which English was a home language, and the families that had *other* home languages. The first two might have had more opportunities to receive input either through TV and the internet, or friends and family they were able to see in the country. On the other hand, families with languages other than Norwegian or English might have more likely missed the contact with family members in that language.

Despite the overall positive results, we acknowledge the limitations of this study. A survey of this kind provides a good overview of family experiences during the pandemic but may reduce the depth of the responses. People may prefer neutral over extreme response options in a Likert scale. In the current study, however, participants were given space to comment and elaborate, which provided valuable insights, some of which have been included in the discussion of our results. We acknowledge that the inclusion of families with children with a wide range of ages may be somewhat challenging for specific questions targeting literacy practices. The aggregate variables included questions regarding parents' reading to their children, as well as children's own reading practices. This could certainly have created some noise in the data. However, because many families had children of different ages, for whom all literacy questions were relevant, the exclusion of these questions would have prompted significant data loss. We nevertheless advise the reader to be mindful of this methodological limitation. Another potential challenge is the novelty of the survey, which is relatively new and has not yet been validated. Having said that, its comparative English format has been used in the UK and Ireland contexts, although we made adaptations to accommodate the Norwegian context. Another issue lies in the unbalanced representation of high SES families in the sample, which may have influenced parental expectations on HL use, as well as positive associations and attachment to the heritage culture and language of the family (Gatt et al. 2020; Pace et al. 2017; Rowe 2018). Many of the families in this sample have European language backgrounds and might have a more positive migrant experience than those coming from other parts of the world, who are more likely to experience racialization, minoritization and discrimination (Gozdziak 2021:66; Lomeu Gomes and Lanza 2022). Moreover, there were no responses to the questionnaire from Indigenous minorities in Norway such as the Sámi, nor from the Kven.

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The limited representation of lower-SES families may have skewed our results, in particular with respect to Norwegian, as these families might lack the resources and time to invest in their own and their children's knowledge of Norwegian as this was a second language in the household. Being multilingual is an incredibly complex experience, and impossible to generalize across individuals with different cultural and linguistic experiences, but the specific characteristic of these subjects makes us believe this particular background might have influenced the overall positive attitudes towards multilingualism and HL in our study. In addition to the SES of the sample, the particular location where we collected our data is of important significance for our results. While Norway is a linguistically diverse country, it also has a well-established welfare system, low rates of unemployment, strong childcare support, and an overall feeling of social security. Such an environment might also support positive views on multilingualism. In addition, families such as the ones who participated in this study, who might enjoy job security and a culture that promotes work-life balance, might also have more time to dedicate to activities that promote and sustain HL use, like reading and writing, supporting homework and participating in locally organized events in the HL. It would be wrong to assume that multilingual families across the globe share this experience, especially in the extenuating circumstances of the Covid-19 pandemic, which has disproportionally affected some countries and communities over others.

We would like to pay special attention to the finding concerning language as a source of well-being, which was not only of special interest to us but has also caught the attention of the media (Hardach 2020). In our survey, we asked families whether more opportunities to use the HL was a source of well-being in their family, something for which we found an overall positive response. This finding was further supported by the responses in Question 56 ("the use of the other language(s) is a source of tension in my household") with which most families (64 %) expressed disagreement.

Multilingualism as a source of well-being was associated with positive effects of the lockdown in the HL. Similarly, the importance of maintaining regular contact in the HL with family abroad was also a predictor for seeing multilingualism as a source of well-being (see Table 3). This result supports Hollebeke et al.'s (2020) systematic review that shows that positive attitudes towards HL and general well-being around multilingualism are heavily associated with linguistic outcomes in the HL, as well as De Houwer (2020, 2022) who has highlighted the importance of using the HL to maintain parent-child relationships and the overall well-being in the nuclear and extended family. Furthermore, recent research has shown life-satisfaction of children and teenagers in Norway to be associated with time spent online (Milosevic et al. 2022), which aligns with this sample of families' use of online platforms such as FaceTime or Skype to stay in touch with family abroad and its connection with well-

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being. As reported by Crandall et al. (2022), positive associations towards family well-being were likely to decrease depression and anxiety symptoms during the pandemic. It is thus not surprising that positive associations towards multilingualism in the family unit transpire into a stronger feeling of well-being in the families in our study. All in all, we interpret these results as an indication that the use and encouragement of HLs can promote positive associations towards multilingualism, and ultimately, keep multilingualism "alive" in the family environment. We believe this result can be taken as an example that, even in a time of despair, multilingualism can be a resource of resilience and well-being. This is very important considering that migrant families underwent particularly challenging struggles during the harsher months of the Covid-19 pandemic, when traveling to and from other countries was essentially impossible. For many migrant families, spending time in their home county is vital for maintaining their cultural identity, family ties and supporting their children's HLs. In Norway, where extremely strict border control measures were implemented and entry restrictions were maintained for the majority of the pandemic, multilingual families' ability to resort to multilingualism through the various activities presented in this paper might provide a sense of hope for multilingual speakers elsewhere.

It is difficult to estimate to what extent these results can generalize to other contexts and experiences of multilingual families, given the extraordinary circumstances that motivated this study and in which the data were collected. It is particularly challenging to predict whether the overall positive results we have observed for the use of HLs can and will remain after the pandemic when, slowly but surely, life will eventually go back to "normal". That being said, we hope to have shown that *any* circumstance is a *good* circumstance to promote multilingualism and language maintenance. We are aware that raising multilingual children is a hard and arduous task, which is not always supported by the communities and societies we live in. The families in this study showed an extraordinary ability to thrive in an extremely challenging situation, and we would like to use this result to inspire other families to seek that same resilience in their own multilingual experience.

5 Conclusions

This study provided a unique opportunity to investigate the effects of the Covid-19 pandemic in multilingual families in Norway, and how the lockdown, social distancing measures and homeschooling influenced the use of Norwegian and other HLs. This study is inspired by Spolsky's (2004) tripartite model as used in Family Language Policy research, which guided our main research questions on language beliefs, language practices and language management in this sample of families.

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Through an online survey, we collected parental reported information on these questions during the first lockdown in Norway. Taken together, our results showed positive attitudes towards multilingualism, which influenced positive effects of the lockdown on language practices in the HL. Furthermore, promoting activities in Norwegian and the HL during the lockdown was associated with positive effects of the lockdown on Norwegian and the HL respectively. Lastly, our results show that viewing multilingualism as a source of well-being in the family was associated with positive effects of the lockdown on the HL. We believe that the positive trends found in our data might also be influenced by the overall positive ideologies towards multilingualism in Norway, as well as the reasonably safe and secure situation the Norwegian population experienced during the lockdown, due to its well-established welfare system, low rates of unemployment, strong childcare support, and overall feeling of social security, as noted above. While we acknowledge the limitations of using a survey to understand the complexity of multilingual families' experiences during the pandemic, this method allowed us to gain swift access to a large sample of families across the country during a time in which in-person interaction was not possible, and gave us a unique opportunity to study a once-in-a-lifetime linguistic scenario. It is important to emphasize that our results can only inform about the first phase of the lockdown which, although it was the most restrictive in Norway, limits our ability to predict whether these trends continued throughout the pandemic, and most importantly, if and to what extent the apparent positive effects of the pandemic have had a longstanding effect for these families. Having said that, we believe the results of this study can and do offer a new side of multilingualism: a source of resilience and connection even under such extenuating circumstances. We hope this study can serve as evidence of hope and resilience to other families across the world.

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Appendix I: Background information on participants (Background section)

Languages represented in the questionnaire

Language	*N*
Afrikaans	3
Arabic	3
Azerbaijani	1
Bosnian	2
Bulgarian	2
Cantonese	1
Catalan	2
Chinese	1
Croatian	1
Czech	1
Danish	4
Dutch	16
English	80
Farsi	1
Filipino	2
Finnish	8
Flemish	1
French	15
German	18
Greek	3
Hindi	3
Hungarian	3
Icelandic	2
Italian	6
Japanese	3
Kirundi	1
Kotokoli	1
Latvian	2
Lithuanian	1
Malayam	1
Norwegian	106
Persian	1
Polish	2
Portuguese	8
Romanian	4
Russian	9
Sami	4
Serbian	1
Slovakian	3

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(continued)

Language	*N*
Spanish	28
Swedish	3
Ukranian	1
Urdu	3
Vietnamese	1
Zulu	1

Distribution of responses per region

Region	Total responses	Percentage (%)
Eastern Norway outside Greater Oslo Region	18	10
Greater Oslo Region	106	57
Northern Norway	12	6
Southern Norway	4	2
Trøndelag	8	4
Western Norway	40	21

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Distribution of languages per household

N languages at home	Percentage (%)
1	11
2	67
3	20
4	1.5
5	0.5

Distribution of families with Norwegian at home

Norwegian at home	Total responses	Percentage (%)
Yes	106	56
No	82	46

Appendix II: Questionnaire (in English)

Background questions

3. Where do you currently live?
4. How many of your children currently live with you in your household?

4.1. How old are the children living with you in your household?

5. Do any of the children have special education needs?

5.1. Please specify.

6. What type of educational system does the child/children attend.

6.1. Please specify if you chose "other" in the previous question.

7. Do your child/children attend a complementary school (e.g. a Saturday School)?
8. What is your relationship to the child/children?

8.1. Please specify.

9. Which language(s) does Parent 1 speak to the child/children?
10. Which language(s) does Parent 2 speak to the child/children?
11. If there are other adults currently living with you and your child/children, please state:

1. *their relationship to the child/children;*
2. *the language(s) that they speak to the child/children.*

For example: grandmother: Italian only; grandfather: English and Italian.

12. Which language(s) do the child/children speak to Parent 1?

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13. Which language(s) do the child/children speak to Parent 2?
14. Which language(s) do the children speak to each other?
15. For each adult currently living in your household, please indicate how well they speak Norwegian.
15.1. For each adult currently living in your household, please indicate how well they speak other languages.
16. For each adult currently living in your household, please indicate their highest educational qualification.

Beliefs about multilingualism

In this section we will ask you some questions about the importance of Norwegian and the other language(s) in your family to you and to your child/children.

If your child/children are very young some of these statements may be irrelevant and therefore you can tick the "not important" button.

If your child/children do not attend a complementary school, please skip statement 26.

By "other language(s)", we mean the language(s) you use in your family in addition to Norwegian.

Please rate the following statements.

17. Being multilingual is an important part of my personal identity.
18. Being multilingual is an important part of my child/children's personal identity.
19. Keeping in regular contact with members of our family who do not speak Norwegian is important to me.
20. Keeping in regular contact with members of our family who do not speak Norwegian is important to my child/children.
21. Doing well at school is important in our family.
22. Norwegian is important for doing well at school.
23. English is important for doing well at school.
24. My child/children's other language(s) are important for doing well at school.
25. Speaking other language(s) is important for my child/children's future career options.
26. Attending a complementary school (e.g. a Saturday School) is important for my child/children's other language(s).
27. It is important that my child/children can use their other language(s) to speak with family members.
28. It is important that my child/children can read in their other language(s).
29. It is important that my child/children can write in their other language(s).

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Language use in your family during the lockdown and the social distancing measures

In this section we will ask you about the frequency of language activities in your household during the current lockdown and social distancing measures. When you answer these questions, please try to think about how often you carry out these activities in each of the languages.

By "other language(s)", we mean the language(s) you use in your family in addition to Norwegian.

If the statement is irrelevant – for example, because your child/children are too old to be helped with their homework, or because they do not attend a complementary school – please say "never".

Please rate the following statements.

30. We read to our child/children in Norwegian at home.
31. We read to our child/children in their other language(s) at home.
32. My child/children get help at home with their Norwegian homework.
33. My child/children get help at home with reading in their other language(s).
34. My child/children watch TV/streamed internet programmes in Norwegian.
35. My child/children watch TV/streamed internet programmes in English.
36. My child/children watch TV/streamed internet programmes in their other language(s).
37. My child/children play computer games in Norwegian.
38. My child/children play computer games in English.
39. My child/children play computer games in their other language(s).
40. My child/children speak Norwegian to their sibling(s).
41. My child/children speak the other language(s) to their siblings.
42. My child/children speak Norwegian to friends and family over the internet (e.g. via Skype, WhatsApp, FaceTime).
43. My child/children speak their other language(s) to friends and family over the internet (e.g. via Skype, WhatsApp, FaceTime).
44. My child/children read books in Norwegian.
45. My child/children read books in their other language(s).
46. My child/children write in Norwegian.
47. My child/children write in their other language(s)

Impact of school closures and social distancing measures

In this section we will ask you some questions on how you think school closures and social distancing measures during the lockdown may affect your child/children's Norwegian and their other language(s).

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If the statement is irrelevant – for example because your child/children are too young for homeschooling – please choose "strongly disagree".

By "other language(s)", we mean the language(s) you use in your family in addition to Norwegian.

Please rate the following statements.

48. My child/children's spoken Norwegian will be negatively affected by school closures and social distancing measures.
49. Homeschooling is having a positive impact on my child/children's spoken Norwegian.
50. Homeschooling is an opportunity for my child/children to read more in Norwegian.
51. Homeschooling is having a positive impact on my child/children's spoken other languages.
52. Homeschooling is an opportunity for my child/children to read more in their other languages.
53. Time at home is an opportunity for my child/children to speak their other language(s) more with other family members in the household.
54. My child/children use their other language(s) more often than before the lockdown to communicate with family and friends over the internet (e.g. on Skype or WhatsApp).
55. My child/children have more opportunities than before the lockdown to use their other language(s) for games and recreational activities at home.
56. Use of the other language(s) is a source of tension in my household.
57. I miss the support of other parents/friends who speak our family's other language(s).
58. Internet resources to support my children's other language(s) are useful during school closures.
59. Internet resources to support my child/children's Norwegian are useful during school closures.
60. Internet resources to support my child/children's English are useful during school closures.
61. Overall my child/children hear their other language(s) more now than before the lockdown.
62. Overall my child/children speak their other language(s) more now than before the lockdown.
63. Overall my child/children read in their other language(s) more now than before the lockdown.
64. More opportunities to use the other language(s) are a source of family wellbeing.

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Anything else? Let us know!

If there is any information that you would like to share about your multilingual family, tell us in the box below. Also, if you have any comments about the survey, please let us know.

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Article II

It is impossible to conclude that a behavior is caused by a gene, a hormone, a childhood trauma, because the second you invoke one type of explanation, you are de facto invoking them all.

– Robert Sapolsky –

Behave: The Biology of Humans at Our Best and Worst

Ready, Steady, Switch! Limited evidence for the role of executive functions in bilingual language control in children

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Abstract:

This study investigated the extent to which executive functions (EFs) are recruited in language switching in children in a cued picture naming (CN) task. We expected to find associations between CN and EF tasks tapping into inhibitory control and shifting. The second goal was to compare children's everyday language control ability at home, as reported by parents, with their switching ability in the CN lab task, as well as with EF performance. We predicted that children who are better able to respond to stricter dual-language contexts at home would have better performance in CN in the lab, as well as better EF performance. Data from Norwegian-Spanish- and Finnish-Swedish-speaking children (N = 45), ages 5-7 were collected in Norway and Finland, respectively. Contrary to our expectations, our data revealed no consistent associations between CN and EF tasks. CN mixing costs were predicted by the color-shape switch costs and the Flanker task, but the latter effect was in the unexpected direction. The majority of the analyses did not show significant associations. CN switching costs were not associated with any of the EF tests. Contrary to our second prediction, we found neither associations between children's parent-reported everyday language control ability and language control in the lab, nor with EF performance. Our research adds to a limited number of studies examining the role of EFs in children's language switching performance, and provides little evidence that EFs are engaged in children's language control when children have some years of bilingual experience.

1. Introduction

One of the most studied topics in the field of bilingualism in the last two decades is the bilingual cognitive advantage: the assumption that bilinguals can outperform monolinguals in a number of executive functions (EFs) (Bialystok & Viswanathan, 2009) such as attention (Bialystok & Martin, 2004), working memory (Morales et al., 2013), inhibitory control (Hilchey & Klein, 2011), or cognitive flexibility, also known as task shifting (Prior & MacWhinney, 2010). The bilingual advantage hypothesis presupposes that bilingual language use engages domain-general EFs, such as inhibitory control and shifting, and that language switching can train EFs (Bialystok, 2009; Bialystok & Viswanathan, 2009). According to this assumption, when bilingual speakers switch between languages, they must inhibit the language that was previously being used (thus engaging inhibitory control) and alternate languages in a similar manner to the way one would shift between non-verbal tasks. However, this hypothesis has faced major challenges. A number of meta-analyses and systematic reviews have questioned whether a broad bilingual advantage exists (e.g., de Bruin et al., 2015; Donnelly, et al., 2019; Gunnerud et al., 2020; Lehtonen et al., 2018; Lowe et al., 2021; Monnier et al., 2022; Paap et al., 2013; 2018), thus questioning the training hypothesis of domain-general abilities and the idea that bilinguals could enjoy any such advantage. In addition, one might need to question the more fundamental assumption as to whether language switching in fact engages EFs. If this is not the case, language switching could not train general EF, either. The present study addresses the assumption of whether language switching in children engages EFs.

The theoretical basis by which language switching engages EFs is that bilinguals' two languages remain active even when there is one target language for communication (Grosjean, 1989; Marian & Spivey, 2003). Thus, they must efficiently keep from interfering with each other by exercising language control, which has been suggested to be regulated by domain-general executive control (Craik & Bialystok, 2006; Green, 1998; Green & Abutalebi, 2013). Furthermore, it has been claimed that any potential executive demands in language switching are driven by the contexts in which speakers use their languages. The Adaptive Control hypothesis (ACH; Green & Abutalebi, 2013) proposes that the context of everyday language switching governs how strongly different EF processes are engaged, since the speaker's linguistic context creates different cognitive demands upon them to use the right language. The ACH distinguishes three different language

switching contexts: a single-language, a dual-language, and dense code-switching context. The single-language context applies when a speaker uses two languages in two clearly distinct contexts (e.g., at home versus at school). The dual-language context represents situations in which a speaker might be required to use one language with one speaker and switch to another with a different speaker within the same context, remaining aware of the interlocutor's needs. In the dense code-switching context, the speaker has relative freedom to use any language, based on which word or expression is more easily accessible, and to switch when desired without a break in communication, because the interlocutor is a bilingual speaker, him- or herself. Under the ACH, the dual-language context is the most cognitively demanding because it involves almost all control processes proposed by Green & Abulatebi (2013): goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, and task engagement. The plurality of control processes involved make it more likely to engage EFs than the single contexts, which requires goal maintenance and interference control, or the dense context, which only requires opportunistic planning. Ultimately, the dual-context demands more awareness of the linguistic environment, the interlocutor's needs, and control to use the target language.

Recently, it has been questioned whether domain-general executive control is always engaged in language control, even in dual-language contexts (Jylkkä et al., 2020; Lehtonen et al., 2023; Paap, 2018). Research in other areas of cognition has argued for the importance of automatization, and addressed conditions where EFs are recruited in the carrying out of a particular task. In their Triarchic Theory of Learning, Chein and Schneider (2012) discuss three stages of learning from the acquisition of a new behavior to its relative automaticity: the metacognitive system, the cognitive control network, and the representation system. According to the authors, these stages of learning support the establishment of new behavioral routines when presented with novel tasks, and ultimately provide a pathway for automaticity of certain behaviors. While Chein and Schneider (2012) discuss how certain brain regions disengage earlier than others in the process of learning, they also raise the role of cognition in the learning of new tasks. In their proposal, EFs would likely be engaged in the learning of new tasks in novel contexts prior to the establishment of behavioral routines or skills (Chein & Schneider, 2012). Although these authors do not make claims about bilingualism, others have broadened this "skill learning" account into hypotheses of bilingual language control. Paap (2018) has applied these findings to the context of language learning by

developing the "Controlled Dose Hypothesis." This account predicts that the process of language learning, similar to the process of learning a new task, may boost EF ability early on, but that such effects dissipate rapidly, as familiarity and automatization of the task increase. Therefore, this boost of EF ability is more likely to occur in the early stages of L2 learning. A similar account has been recently presented by Lehtonen and colleagues (2023; see also Jylkkä, 2017), who specify the assumptions that the skill learning view could take in the field of bilingualism. They propose that the reliance of language control on EFs is likely to diminish with accumulating bilingual experience. Following this hypothesis, EFs would be more actively engaged when the subject is confronted with a novel task. They would make use of general inhibitory control or cognitive flexibility to resolve the newly presented task and to create strategies to perform it effectively. However, once the task is familiar enough, automatization has largely taken place, after which fewer overall EFs are needed. Following this claim, bilingual speakers for whom switching is a daily activity – even in a dual-language context – might no longer recruit EFs for this task.

The skill learning hypothesis brings forward an important question in understanding EFs in relation to language control: how do age and development affect these cognitive processes? Most of the hypotheses described above are rooted in what we know about adult brains and cognitive processes. However, cognition changes across our lifespan: from crucial development in the first few years of life, continuing to adulthood, and decline in old age. The pre-frontal cortex, which matures greatly in the first five years of life (Best & Miller, 2010), is highly interconnected with the development of EFs, as well as language. Considering continuous cognitive development, which can be influenced by different environment factors, an interesting question is whether language switching engages domain-general EFs in children. We might presume that children have not yet accumulated enough experience in language switching for it to become an automatic process (Lehtonen et al., 2023). There is some evidence that language switching may rely on domain-general EFs in bilingual children (Lehtonen et al., 2023), but there are thus far few studies directly addressing this relationship.

According to the skill learning account, novel tasks are likely to rely more on EFs than familiar ones. It is therefore possible that a laboratory-based language switching task, which presumably entails some novel aspects compared to everyday language switching, shows higher correlations with EF task performance than switching in a natural environment. Here, we also ask whether the

language control ability of children in an everyday dual-language context in the family is related to their EF performance. If everyday language switching ability relies on EFs in children, we should also see associations between children's everyday language control ability and their EF performance.

Thus, we study the connection between language switching performance in the lab vs. everyday language control ability in those children who are functioning in dual-language contexts in their homes. From a methodological point of view, there are few existing studies that compare lab task performance to everyday language use (for exceptions, see, e.g., Jylkkä et al., 2017; 2020). This is the case even though finding such associations would provide support for ecological validity of commonly used lab tasks, such as cued picture naming with language switching (CN; for criticism on this task, see, e.g., Blanco-Elorrieta & Pylkkänen, 2018).

1.1. Language switching studies in children.

Relatively few studies have thus far explored language switching in children in a controlled lab environment with a picture naming paradigm (Gross & Kaushanskaya, 2015; Kubota et al., 2020; de Bruin et al., 2020). Of these, only Kubota et al. (2020) investigated associations between CN and EF tasks in the lab. The authors explored whether development in executive control and bilingual experience predicted language control in bilingual children. A forced cued language switching task and a Simon task showed that cognitive development overall predicted language control, indicating an overlap between executive control and language control: CN mixing costs were predicted by exposure to the L2, and were modulated by improvement in performance in the Simon task. Their results seem to support the view that EFs are involved in language switching in children, to some extent.

Other studies have measured EFs in relation to language switching in children with either free play sessions (Kuzyk et al., 2019; Smolak et al., 2020; Kang & Lust, 2018; Gross & Kaushanskaya, 2020), or parental reports (Kaushanskaya & Crespo, 2019; Bosma & Blom, 2019). Most of these studies report that proficiency is an important factor that drives language switching in children, often arguing that language competence plays a more crucial role in children than EFs (Gross & Kaushanskaya, 2020; Smolak et al., 2020). However, they diverge in that some of these studies look at code-switching as a predictor of language skills, whereas others infer how language skills may explain switching in children. For those studies that included EF measures, the relationship

between EF performance and language switching is tacit at best, as language control was not measured in the lab. Nonetheless, these studies provide meaningful evidence about the role of the environment in children's switching.

Contrary to measures of spontaneous switching or parental reports, cued picture naming tasks provide two measures that allow a more direct assessment of speakers 'ability to switch languages. In this task, participants are required to name pictures in two languages in two different blocks: a single language block, and a mixed language block. A visual cue (such as a flag) indicates the language that must be used for each trial. It has been observed that alternating between languages creates a switch cost, which can be inferred by means of speakers' naming speed when they switch languages. The cost is obtained through the difference in naming speed between switch trials and repetition trials in mixed blocks where both kinds of trials are present. Evidence has often shown that speakers are slower in naming a word in their L1 directly after naming a word in their L2, than they are in naming a word in their L2 after using their L1 (Meuter & Allport, 1999). This asymmetric switching cost has been taken as evidence of a need to inhibit the stronger language during production of the weaker language, and that inhibitory control is necessary in language switching, although it also been questioned whether switch costs are an index for reactive inhibition in bilingual language control (Bobb & Wodniecka, 2013; Gade et al., 2021). In addition to switching costs, CN tasks provide a measure for mixing costs, calculated as the difference between repetition trials in mixed blocks and single trials in single blocks, assumedly reflecting monitoring the use of languages or preparedness to switch.

In sum, studies aiming to establish a direct connection between children's EF performance, language switching in the lab, and their linguistic home environment are rare. We lack in-depth understanding as to whether language control in children, as measured in the lab, may be associated with domain-general executive control, as well as with their everyday language control ability at home.

1.2. The present study

There is still limited evidence on the role of cognitive control in language switching in children, and how development affects these cognitive processes. The primary aim of our study was to understand the extent to which language switching engages EFs in children. According to previous findings (see Lehtonen et al., 2023, for a review), we would expect to find some degree of

association between EFs and language control in the lab with a CN paradigm. In a dual-language context that the CN task represents, domain-general EFs should be engaged according to the ACH (Green & Abutalebi, 2013). Similarly, according to the skill learning framework, novel tasks should engage EFs, and we assume that young children might not have developed automatized subroutines for language switching yet. Furthermore, we were interested in understanding whether children's everyday switching ability is associated with their language control ability in the lab, and with EF performance. We assumed that if everyday bilingual language control engages EFs, we should also see associations between children's language control ability at home, as reported by parents and EF performance. We also expected to see associations between the lab-based CN task and everyday language control ability.

To address these questions, bilingual children aged 5-7 performed a cued picture naming language switching task and EF tasks in the laboratory. Their language exposure and everyday language control ability at home were probed by parental questionnaires, and their language skills were evaluated by comprehension and production tests.

2. Method

2.1 Participants

This study included parallel data collection of Norwegian-Spanish-speaking children in Norway, and of Finnish-Swedish-speaking children in Finland. Other than the language materials (i.e., language proficiency tests and the specific linguistic stimuli in the language-switching task and the color-shape task), the experiment was equivalent in both countries (cf. section 2.2).

A total of 45 children (M age, 76 months; SD, 0.53; range, 48-100; 23 boys) participated in this study. 19 Norwegian-Spanish speaking children were tested in Norway, and 26 Finnish-Swedish children in Finland. We did not exclude children who were exposed to other languages as well – for instance, English was often the language of communication between the parents, especially in Norway – but we required that they were exposed to Norwegian and Spanish or Finnish and Swedish daily and that they were sufficiently fluent in each language pair to hold a conversation. As Table 1 indicates, The Finnish-Swedish sample appears to be more dominant for Swedish, whereas the Norwegian-Spanish is more balanced for each language. However, Cross-linguistic Lexical Task scores where quite high for all languages, reflecting their high proficiency in the languages. We excluded children who had learning and cognitive difficulties such as ADHD,

autism spectrum disorder, or hearing or visual impairments. We collected information on SES of the parents in these families, the majority of which had at least one parent with a Bachelor's degree (65%), a Master's degree (35%), or a PhD (3%).

In order to assess the associations between everyday language control ability and language control ability in the lab (question 2), we narrowed the sample to a subset of families (N =18) who reported a "stricter dual-language culture," which resembled a dual-language like context at home where each parent was relatively consistently using one language with the child and encouraging the child to use only that language when speaking to them. The motivation here was that it is possible to obtain a measure of everyday language control ability only in families that enforce a dual-language context. We obtained this sample through the questions in the parental report that addressed a) the extent to which the parent reported not mixing languages in a conversation with their child, b) the degree to which each parent encouraged the child to respond in the language used, and c) the extent to which the child was able to meet those demands. We selected the families with parents who responded 50% or more to question b). Of those families, we selected the "stricter" parent, and measured the child's switching behavior (c) as a response to those demands. We also checked whether these parents reported that they themselves switched languages with their children (a), which did not seem to be the case for this group of parents. In the subset of the sample, at least one of the parents had a Bachelor's degree (55%), a Master's degree (33%), or a PhD degree (3%). Thus, the SES distribution for the strict culture sample, as compared to the full sample, was relatively similar.

Table 1. Language background characteristics for participants (N = 45) based on proficiency measures and parent reporting. Average percentage scores are reported.

	Norwegian	**Spanish**	**Finnish**	**Swedish**
Proficiency % score	74%	70%	77%	87%
Dominance %	53%	47%	19%	81%

2.2 Procedure and materials

In Norway, the data processing plan was assessed by the Norwegian Agency for Shared Services in Education and Research in order to ensure that data collected in the project was processed in

accordance with data protection legislation (reference number 408035). Data collection in Finland was evaluated and approved by the Ethics Committee for Human Sciences at the University of Turku.

Parents provided digital consent for their children to participate in this study. In Norway, children came to the laboratory for the two one-hour-long sessions, while data collection in Finland took place in kindergartens, in a quiet room, in similar sessions. In either case, the sessions were no further than two weeks apart. Sessions I and II were counterbalanced, such that half of the participants took Session II first. Session I consisted of an EF test battery of four cognitive tests: Flanker and Nonverbal Stroop Card Sorting Test (NSCST) to measure inhibitory control, and the Dimensional Change Card Sort (DCCS) and Color-Shape task to measure switching. The order of the tests was counterbalanced with a Latin Square design. Session II included the cued picture naming language switching task preceded by the two versions of Cross-Linguistic Tasks (CLT) in Norwegian (Simonsen et al., 2014) and Spanish (Cantú Sanchez, 2016), or Finnish (Kunnari, 2013) and Swedish (Ringblom et al., 2014) to assess the child's comprehension and production of verbs in each language. The language assessment was always performed at the start of the session, and the languages of the CLT were counterbalanced. In the language switching task, children completed two single language blocks, with order counterbalanced, followed by three mixed blocks.

Session I was carried out in the preferred language of the child by an experimenter fluent in that language, in order to make the child most comfortable in the testing situation. Session II was carried out by a bilingual experimenter, as the tasks included two languages. In addition to the two sessions the children participated in, parents filled out a survey about language switching practices at home and responded to questions of the Bilingual Language Experience Calculator (BiLEC; Unsworth, 2013) via telephone or Zoom, or filled out the questionnaire themselves if an appointment was not possible. All tasks were run in Presentation software (Version 0.80, Neurobehavioural Systems, Inc., Berkeley, CA, www.neurobs.com) on a laptop.

Picture naming task

We designed a non-voluntary cued picture-naming (CN) task according to previous literature (Gross & Kaushanskaya, 2015, 2018; Kubota et al., 2019; de Bruin et al., 2020) to test children's language switching abilities. The task consisted of five blocks: two single blocks and three mixed

blocks, which allowed us to provide several breaks for children to complete the tasks. Participants named aloud pictures in Norwegian/Spanish or Finnish/Swedish according to a given language cue. A total of 20 individual pictures were selected. The single blocks consisted of 20 experimental items, and in them, the pictures were to be named in only one language. In the mixed blocks, a cue informed the participant about which language to use for naming of the picture. In these blocks, the same pictures used in single blocks were repeated twice (40). For all blocks, the cues remained on the screen throughout each trial to reduce working memory demands. Practice blocks were administered prior to the single blocks and the first mixed block. There were three types of trials in the CN task. The single blocks consisted of single trials only, where the same language was repeated for all items. The mixed blocks included switch trials, where the target language was different from the previous trial, and repetition trials, for which the target language was the same as for the previous trial. We obtained two measures from these three trial types: a) mixing costs, the difference in performance between single and repetition trials across the single and mixed blocks, and b) switching costs, the difference in performance between switch and repetition trials within the mixed blocks.

The order of the trials was randomized in the single blocks, and pseudorandomized in the mixed blocks. We created eight8 lists for the mixed blocks to control for order effects, and to assure a sufficient number of switches in each block (16; 8 to each language) and repetition trials (23). We chose a proportion of 40% switches to 60% repetition trials to avoid predictability of the switches. There were no more than 4 consecutive trials of the same type. The total number of trials was 160, 40 single trials (20 in each language) and 120 mixed trials, with 48 switch trials and 69 repetition trials. The first trial of every mixed block did not count as either switch or repetition. The children completed 5 practice trials for each of the single-language blocks and 16 practice trials for the mixed language block.

In contrast to studies on adults that often use flags as cues, we selected drawings of two different girls to make it more child-friendly. The participants were told that each girl, who also had a distinctly Spanish, Norwegian, Finnish, or Swedish name, could only speak one language (either Spanish or Norwegian in the experiment in Norway, and Finnish or Swedish in the experiment in Finland), and that the participants needed to make sure they would understand the words that were said to them. The oral responses were recorded for later analysis.

The pictures were selected from the MultiPic Project (Duñabeitia et al., 2018). The words were matched across languages (Norwegian with Spanish, and Finnish with Swedish) for mean frequency (*Ordforrådet*, Lind, et al., 2015 for Norwegian; *Spanish corpus (esTenTen)* for Spanish; *Turun Sanomat* for Finnish and *Göteborg-Posten* for Swedish, Laine & Virtanen, 1999) age of acquisition when available (Stanford Wordbank, López Ornat, et al., 2005; Simonsen et al., 2014), and number of alternative names. Cognates were avoided. Each picture appeared on a white screen in a speech bubble. The cue appeared slightly to the right and above the target picture. A cue was given in all blocks to help participants familiarize with the girl who was supposed to speak each language. Each trial lasted for a maximum of 4 seconds. A trial began with a white screen and a fixation cross for 200 ms, followed by a blank screen for 500 ms, and then the picture appeared simultaneously with a visual cue (girl denoting language). Both the cue and the picture remained on the screen for 4000ms, regardless of when the response was produced. There was a 500 ms interval between trials. The instructions for the single blocks were given in the corresponding language. For the mixed blocks, the instruction was given in both languages by a bilingual research assistant.

Executive tasks

Flanker task

We used an adapted version of the Flanker task (Eriksen & Eriksen, 1974) as a measure of inhibition and selective attention. In this version of the task, children were presented with pictures of 5 fish instead of arrows, based on Park et al. (2018). On congruent trials, all fish pointed in the same direction (e.g. >>>>>) and on incongruent trials, the central fish pointed in the opposite direction (>><>>). In neutral trials, a picture of vertical seaweed substituted all but the central fish. The child's task was to correctly identify the direction of the fish in the trials by using the left or right button in the response box. We focused on the Flanker effect, which is the difference between the congruent and incongruent trials measured by means of accuracy rates or RTs. Each trial began with a fixation cross in the shape of a star on a blue background to simulate the sea. The maximum duration of each trial was 1700 ms with an inter-stimulus interval (ISI) of 1000 ms. There were 60 testing trials preceded by 18 training trials (6 congruent + 6 incongruent + 6 neutral). Children were required to respond accurately on at least 3 of the 6 training trials in order to proceed to the testing phase. In case they did not, 2 series of practice items were added. The testing phase

consisted of 60 trials, including congruent (20) and incongruent (20) and neutral (20) trials. In the statistical analysis, neutral trials were discarded.

Nonverbal Stroop Card Sorting Test

An adapted, computerized version of the Nonverbal Stroop Card Sorting Test (NSCST) was used to assess children's inhibitory control. This is a widely used test for inhibitory control across populations from 3 to 70 years of age. The test is a non-verbal version of the classic Stroop test that is particularly suitable for young children. In this computerized version, the participant must place each card in one of the four stacks which each correspond to a specific color (red, blue, yellow, green). The cards are numbered in a specific order for all participants. The test consists of a congruent condition followed by an incongruent condition. The difference in performance between these two conditions is called the Stroop effect, which is used as a proxy for inhibitory control. In the congruent condition, the cards include two rectangular shapes of the same color (e.g. blue) with a white cross in one of the colors. The participant must place the card in the right color. In the incongruent condition, each rectangular shape in the card represents a different color (e.g. red and blue). The white cross in one of the colored rectangular shape indicates where the card must be placed. The Stroop effect mean for each participant was used in the statistical analysis.

Dimensional Card Sorting Test (DCCS)

The Dimensional Change Card Sorting test is widely used to measure shifting in children from 3 to 7 years of age. We created and adapted a computerized version of the task similar to Park et al. (2018). In our version, the test consisted of two target cards (a blue fish and a red rabbit) that remained the same throughout the experiment. The task consists of a (pre-switch) color task and (post switch) shape task. Child participants received a practice round of 6 items (3 red fish and 3 blue rabbits) in randomized order. Following the practice round, children performed the color task, where they received 3 red fish and 3 blue rabbits in randomized order. Children moved directly to the shape condition explained by the experimenter, where they again received 3 red fish and 3 blue rabbits that now had to be sorted according to their shape, and not their color. The task ended with a mixed cue condition, where a cue indicated whether children could respond according to color (rainbow) or shape (paw). In the mixed condition, the distribution was the following: 11 red fish

(color) 11 blue rabbits (shape), 4 red fish (shape) and 4 blue rabbits (shape). In our study, we used average accuracy performance in the mixed block in the statistical analysis.

Color-Shape task

We designed a version of the Color-Shape task that emulated, as much as possible, the CN switching task with oral responses. As for the CN task, we also obtained switching and mixing costs from the different trial types. Switching and mixing costs were entered in separate models in the statistical analysis. In contrast to the usual color-shape stimuli, we used cats and fish for the shape block to make it more child friendly. We also selected red and blue for the color block. The cues that indicated color and shape were a rainbow and a paw (as in the DCCS). As in the CN task, the cues remained on the screen throughout each trial.

The task consisted of five blocks: a single (shape) block, a single (color) block, and three mixed (shape/color) blocks. There were 20 trials in the single block and 40 trials in the mixed blocks (following the 20x20x40 design of the picture-naming task). The trials appeared in randomized order in the single blocks and in pseudorandomized order in the mixed block. We created 8 lists to assure the right number of switch trials (16 switches; 8 to color and 8 to shape in each mixed list) and repetition trials (23). The first trial of each block did not count as either switch or repetition. We assured there were no more than 4 consecutive trials of the same type. In addition, we counterbalanced the order of the stimuli (red/blue cat/fish). Each trial had a maximum duration of 4 seconds. A trial started with a fixation cross presented for 200 ms, followed by a blank screen for 500 ms. Both the cue and target remained on the screen for a maximum duration of 4 seconds. A 500 ms inter-trial blank screen interval was presented before the onset of the following trial.

Language assessment tools: Cross-linguistic lexical tasks

We used the cross-linguistic lexical tasks (CLT) to assess children's proficiency in Norwegian (Simonsen et al., 2014) Spanish (Cantú Sanchez, 2016), Finnish (Kunnari, 2013) and Swedish (Ringblom et al., 2014). We presented pdf versions of the tests on a computer screen. Each CLT includes 4 phases that assess production and comprehension of verbs and nouns by means of object/action naming or pointing. In order to minimize the length of the session, children were tested on comprehension and production of verbs only. For the comprehension tasks, children saw four action pictures on the screen, and they were instructed to point at the correct picture (e.g.,

Who is biting?). In the production part of the task, children were asked to name the action that appeared on the screen (e.g., What is she doing? – watching TV).

Children's responses were coded as correct or incorrect based on whether they pointed at or produced the target word. In addition, responses were written on the answer sheet for later analysis. This allowed us to assess responses post-hoc, in case a child's untargeted response was due to his or her language variety (e.g., dialectal differences in Latin American vs. European Spanish). The CLT scores were used to determine the child's dominant language, which was later used to explore asymmetric costs in the CN task. If children differed more than 10% in their CLT score, L1 was assigned to the language with the highest score.

Bilingual Language Experience Calculator

Prior to coming to the lab, parents completed the Bilingual Language Experience Calculator (BiLEC) (Unsworth, 2013) for language input and exposure via zoom or telephone. This allowed us to obtain measures for absolute and cumulative length of exposure to each language, as well as background and linguistic information about children, parents, and other members of the family who spend a significant amount of time with the child. This information allowed us to screen children's language abilities and proficiency to assure they completed the cognitive tasks session in the language in which they were more comfortable.

Language switching questionnaire

In addition to language input and exposure, we asked parents to respond to a short survey on language practices about language mixing in the household. This allowed us to assess the extent of a home dual-language context for each participant and to select the participants who experience a dual-language context in their family. See section 2.1 Participants, for more information about the questions used to select the children for this subsample and to assess their everyday language control ability.

3. Results

This study was preregistered in As Predicted prior to data analysis (08/18/2022; reference number 104957). All analyses were performed in R using mixed effects logistic regression models ((G)LMMs, package lme4, Bates et al., 2015). We focused primarily on accuracy measures, in line

with previous studies in children (Davidson et al., 2006; Diamond & Kirkham, 2005; Gross and Kaushanskaya, 2020), which argue accuracy is a better index for performance in children than reaction times. The dependent variable was always in long format, while the predictors were included as means. Each of the models below was designed to answer one of four questions. Some additions were made to the initial pre-registration to facilitate model fit. Because these models are notoriously hard to fit and converge (Mundry, 2021), we z-transformed some of the covariates that were entered in the models, such as Age and the EF variables. These transformations did not impact the output of the models, but generally facilitated the models to converge. The z-transformed variable for Age in months was always included as an additional covariate in the models. Subject and Item were always added as random effects. Participants were excluded from the analysis if the child appeared distracted and responded randomly during the experiment.

In the following subsections we answer the four questions as formulated in the pre-registration: 1) Do children exhibit switching and mixing costs in CN? 2) Are switching and mixing costs in CN associated with EF performance in the lab? In addition, we investigate 3) To what extent is children's everyday language control ability associated with CN, and 4) EF performance in the lab? In order to explore the latter two potential associations, we selected the families that reported creating a more dual-language environment at home. That is, those families that enforced a stricter switching culture between parents and children, whereby children are encouraged to respond to each parent in one specific language. For this sample of families, we asked whether there are associations between CN in the lab and children's everyday language control ability at home, as well as whether there are associations between EF performance in the lab and children's everyday language control ability at home.

3.1 Switching and mixing costs in cued naming

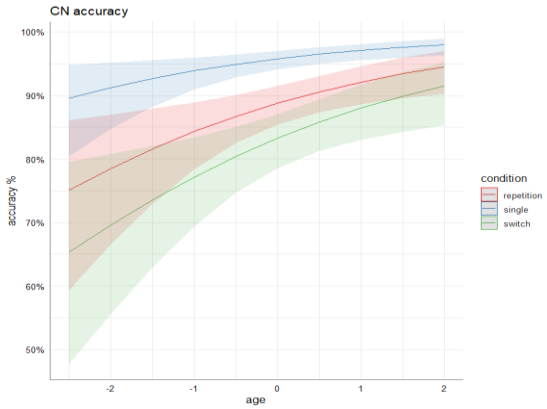
The first model addressed whether children exhibited switching and mixing costs in CN in the lab, that is, whether children's performance was lower in switch trials compared to repetition trials, and in repetition trials compared to single trials. The model examined these with CN performance as the dependent variable, and CN Condition (repetition, switch, and single) as a fixed factor, and Subject and Item as random effects. This model revealed statistically significant switching (E = -.47, SD = .08, z = -5. 61, $p < .001$) and mixing costs (E = 1.05, SD = .12, z = 8.89, $p < .001$) (See Table 2). Participants were less accurate in switch trials, as compared to repetition trials of the

mixed block, and in repetition trials as compared to single-block trials. When including Age as a covariate in the model, accuracy improved with age for all the conditions (Figure 1a), but the effects remained without the inclusion of this covariate.

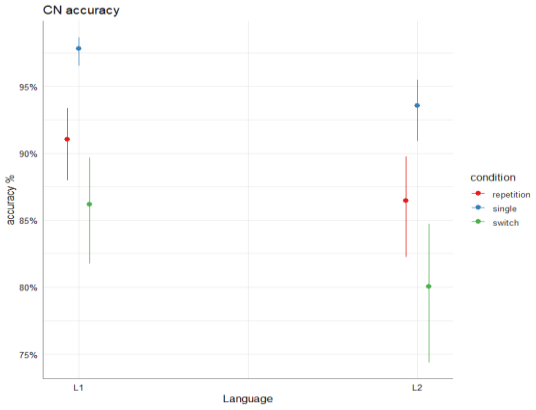
In order to explore a possible asymmetry in switching and mixing costs in CN, we ran a model including the interaction between Language (L1/L2) and Condition, and Age as an additional covariate. Language, which was used here as a proxy for dominance, was determined by CLT production scores, as this domain was considered the most comparable measure to the CN task. For the purpose of this question, "L1" was assigned to the language with the highest score for the child, even though the large majority of children in the study were fairly proficient and balanced in the two languages. We were, nevertheless, interested in exploring whether a difference in language proficiency – even if small – would influence the symmetry of switching and mixing costs. While we found main effects of Language and Age, indicating that accuracy was higher in the assigned L1, and performance improved with age, the interaction between Language and Condition was not significant for switching costs (E = .02, SE = .17, z = .14, p = .89), but it was for mixing costs (E = -.66, SE = .26, z = -2.57, p = .001), which were larger in the L1 than in the L2[1] (See Figure 1b).

Figure 1. Switching and mixing costs and asymmetry costs for cued naming

1a) Switching and mixing costs



1b) Asymmetric costs



[1] Deviating from the preregistration but based on previous studies (Gross & Kaushanskaya, 2015, 2016, 2020), we also included proficiency, measured by CLT production scores, as a fixed factor in an additional analysis with CN and EF measures. While the additional covariate in the model explained some of the variation, the pattern of results did not change.

Table 2. Estimates (standard error in parenthesis) for the switching and mixing cost model, where CN Condition is the main predictor, and the asymmetry model, where Condition interacts with Language. Note: CN = Cued Naming task.

Models	Predictor	CN Switching cost	CN Mixing cost
Cost asymmetry	Condition	-0.47*** (0.08)	1.05*** (0.2)
	Language*Condition	0.02 (0.17)	-0.66* (0.2)

†: p < .10; *: p < .05; **: p < .01; ***: p < .001.

3.2 Cued naming and EF tasks

To analyze our second question regarding associations between the EF tasks and the language switching task, we created four models with CN accuracy as the dependent variable, and the interaction of CN Condition with the mean of one EF measure variable at a time. Age was always added as an additional predictor, and it was significant for all the EF models. A summary of the effects of these models can be viewed in Table 3. The plots for all models are presented in Figure 3.

The model examining the interaction between CN Condition and Flanker task was significant: however, the larger the Flanker effect, the smaller the mixing cost (E = -.21, SE = .02, z = -2.11, p = .03). The Flanker effect did not predict switching costs (E = .10, SE = .01, z = 1.19, p = .23). In the model focusing on the interaction between the NSCST task and CN, the interaction was only marginally significant for mixing costs: the larger the Stroop effect, the larger the mixing cost (E = .24, SE = .14, z = 1.72, p = .08), but it was not significant for switching costs (E = -.11, SE = .08, z = -.1.28, p = .19). Thus, there was a tendency of inhibition tasks to be associated with the magnitude of the mixing costs in the CN task (albeit in opposite directions), but not with the CN switch costs.

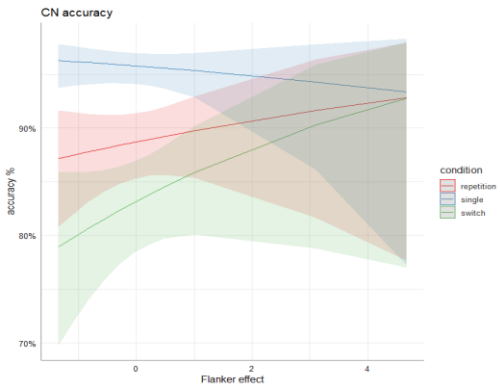
We ran two models to assess the associations between the color-shape task and CN: one model targeted color-shape switching cost, and the other color-shape mixing cost. The first model revealed that the interaction between the switching cost of the color-shape and CN Condition was not significant for switching costs in CN (E = -.01, SE = .01, z = -.71, p = .47), but it was significant for mixing costs in CN (E = .08, SE = .02, z = 3.92, p < .001), suggesting an association between

EF and the CN mixing cost. The larger the switch cost in the color-shape task, the larger the mixing cost in the CN task. The second model assessing the effect of mixing costs of the color-shape task on CN did not reveal a significant interaction for either switching or mixing costs in CN.

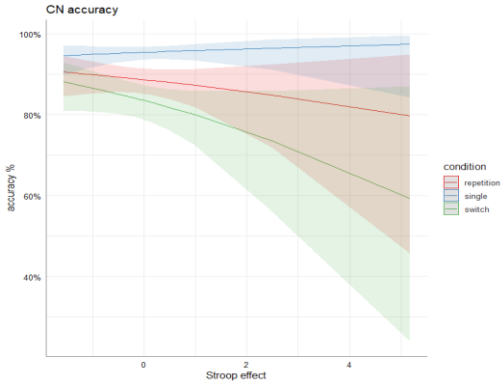
Lastly, the model looking at the interaction between DCCS performance and CN was not significant for either switching (E = -.08, SE = .08, z= -.77, p = .44) or mixing costs of CN (E = -.03, SE = .12, z= -.01, p = .99). Age was the only significant predictor in the model.

Figure 3. Models assessing the different (z-transformed) EF measures in interaction with cued naming condition

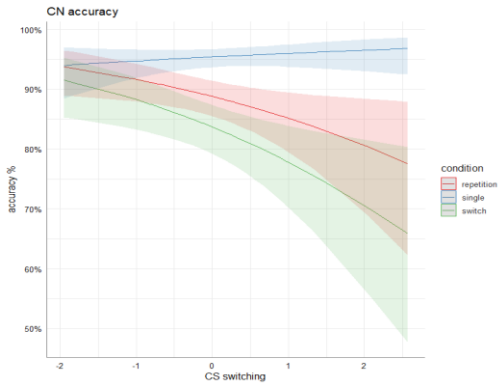
3a) Flanker



3b) Stroop



3c) Color-shape switching



3d) Color-shape mixing

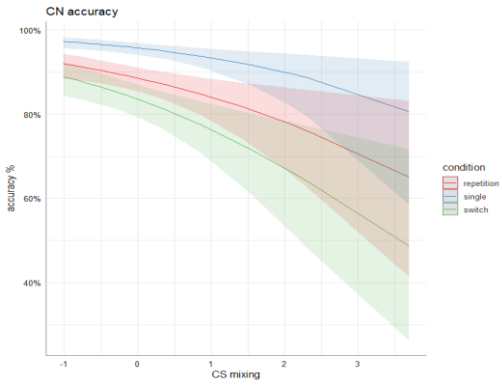


Table 3. Estimates (standard error in parenthesis) for all EF interaction effects with CN Condition, including non-significant ones in the Cued Naming task. Note: CN = Cued Naming task, CS = Color-Shape task

Models	Predictor	CN Switching cost	CN Mixing cost
EF measures	Flanker	0.1 (0.01)	-0.21* (0.02)
	Stroop	-0.1 (0.08)	0.24. (0.14)
	CS switching cost	-0.01 (0.01)	0.08*** (0.02)
	CS mixing cost	0.04(0.01)	-0.004 (0.01)
	DCCS	-0.08 (0.08)	-0.03 (0.12)

†: p < .10; *: p < .05; **: p < .01; ***: p < .001.

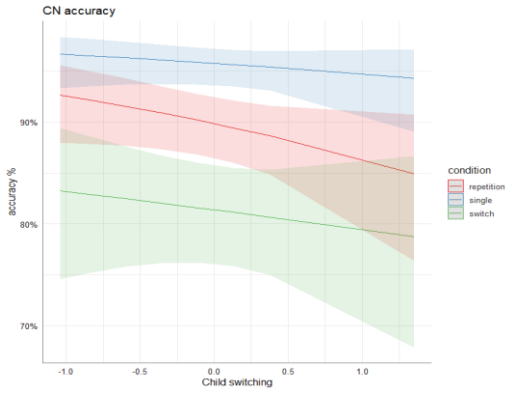
3.3 Cued naming and children's everyday language control

To analyze our third question regarding the associations between children's everyday language control ability as reported by the parents and CN in the lab, we created a model with CN accuracy as the dependent variable and CN Condition in interaction with mean everyday language control ability (Child switching) as fixed factors. Age was an additional predictor, and Subject and Item were added as random effects.

In order to assess the associations between everyday language control ability and language control ability in the lab, we ran a model with the subset of families (N =18) who reported a "stricter dual-language culture" (cf. Section 2.1). The variable "Child switching" reflects the child's unwanted, switching measured in percentages, in response to the parent who encourages the use of one language only. Therefore, an increase in this variable translates into a child's poorer ability to adhere to those demands.

We then analyzed the interaction of condition and child switching tendency and its effect on CN accuracy on this strict culture sample, which was not significant for either switching (E < 0, SE < 0, z = .42, p = .67) or mixing costs (E < 0, SE < 0, z = .001, p = .99) (See Figure 4).

Figure 4. Condition*Child switching with the "strict dual-language culture" subset

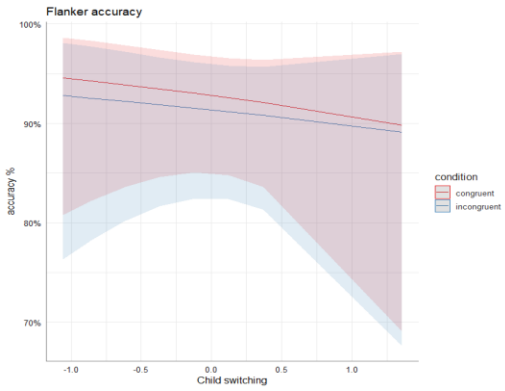


3.4 EF tasks and children's everyday language control

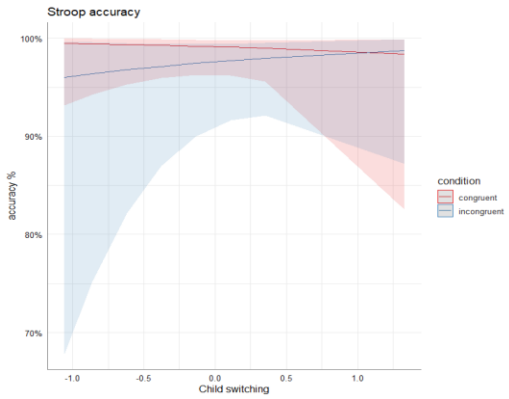
Our fourth and last question addressed the associations between children's everyday language control ability, as reported by the parents and EF. In this model, EF accuracy acted as the dependent variable (in long format) and the interaction of EF condition and mean everyday language control ability as fixed factors. Age was included as an additional covariate, and Subject and Item were added as random effects. We ran these models on the same subset sample as for question 3.3, that is, of those families that created a stricter, more dual-language like context. The plots for all models can be viewed in Figure 5. The first model did not reveal a significant interaction between the Flanker condition and children's everyday language control ability (E = .09, SE = .32, z = .29, p = .77). The model looking at Stroop performance and everyday switching did reveal a significant interaction (E = .1, SE = .42, z = 2.31, p = .02): the worse the children's everyday language control ability, and therefore more difficulties to stick to the demands of stricter dual-language context, the smaller the Stroop effect. The DCCS did not reveal a significant interaction (E = .67, SE = .28, z = 2.49, p = .42). The model exploring the interaction between child switching ability and color-shape condition did not reveal significant interactions for either switching (E = -.05, SE = .18, z = -.29, p = .77) or mixing costs (E = .42, SE = .27, z = 1.55, p = .12).

Figure 5. Effects of everyday switching at home on EF measures

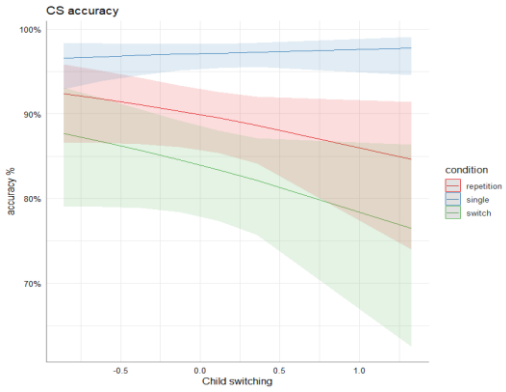
5a) Flanker



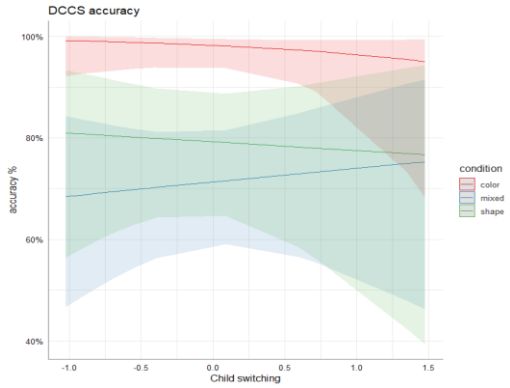
5b) Stroop



5c) Color-shape



5d) DCCS



3.5 Summary of results

As predicted, the statistical analyses revealed overall switching and mixing costs in CN that decreased with age, but no evidence for asymmetric switching costs. However, we found asymmetric mixing costs: mixing costs were larger in the L1 than in the L2. The models exploring associations between EF performance and CN revealed some associations. Specifically, the Flanker and Stroop effect predicted mixing costs in CN, although that relation was in the opposite direction than expected for the Flanker task. We also found associations for the color-shape task and CN: switching cost in the color-shape task predicted mixing costs in CN, however, mixing cost in the color-shape task was not a significant predictor for either switching or mixing costs in CN. We did not find any associations between the DCCS and CN.

When we explored whether experience with a stricter dual-language culture at home was associated with CN or EF performance in the lab, we found few direct associations. Children's ability to stick to the demands of a stricter language culture did not predict CN task performance in the laboratory. Among the four EF tasks, we found only one significant association between EF performance and child switching ability. Specifically, children's everyday language control ability at home predicted mixing costs in the Stroop task, with worse language control being associated with a smaller (better) Stroop effect.

4. Discussion

This study aimed to investigate the extent to which EFs are recruited in language switching in children in a controlled dual-language context using a cued picture naming paradigm. On the assumption that language switching engages EFs in children, our expectation was to find associations between CN and EF performance. The second aim was to understand the extent to which children's everyday switching ability, as assessed by parental reports, is associated with EFs and language control ability in the lab.

Our analysis revealed switching costs for this sample of bilingual children, in line with previous research on voluntary switching in children (de Bruin et al., 2020; Gross & Kaushanskaya, 2015). We also found mixing costs, which are a frequent finding in studies in voluntary (e.g., de Bruin et al., 2020) and non-voluntary switching in children (e.g., Kubota et al., 2020), as well as in cued switching in adults (e.g., Costa et al., 2006; Jylkkä et al., 2020; Meuter & Allport, 1999). Unlike Gross & Kaushanskaya (2020), we did not observe significant asymmetric costs in switching, although proportionally, children made more errors in their L2 (or less dominant language) than in their L1 (more dominant language) on average. However, we did find asymmetric mixing costs in the non-dominant language, similarly to Kubota et al. (2020).

With regard to whether these switching and mixing costs are related to executive control, our data revealed only some associations between EF performance and CN task measures. Specifically, we found associations between EF tasks and mixing costs, but not switching costs. The two EF tasks tapping into inhibition predicted mixing costs in CN. One of these, Flanker, produced an effect that was in the unexpected direction, as a larger Flanker effect is assumed to represent increased difficulty to inhibit distractors in incongruent trials, as opposed to congruent trials. However, previous research has shown similar counterintuitive results for a Simon task, which predicted a

smaller mixing cost in CN (Jylkkä et al., 2018). As for the Stroop effect, it only marginally predicted mixing costs, but in the expected direction. The EF tasks tapping into shifting, in turn, revealed an association between the color-shape task and mixing costs in CN. However, our analysis did not show any associations between the DCCS task and CN. The pattern found for the color-shape task showed that mixing costs in CN were positively associated with the switch cost in the color-shape: larger switching costs in the color-shape task predicted increased mixing costs in CN. In contrast to the mixing costs, none of the EF tasks predicted switching costs in CN. Based on our data, therefore, EF performance was sometimes associated with CN mixing, but not CN switching. From this result, we could infer that monitoring, or sustained control processes, may have some role in children's language switching, but reactive EF does not.

Overall, the majority of the present analyses did not show significant associations between children's language switching performance and EFs. As for CN switching costs, no significant associations were found in any of the analyses, neither for inhibition nor set-shifting tasks. This finding thus does not provide support for the view that language switching engages domain-general EFs in children. This finding is also in contrast to Kubota et al.'s (2020) study where an association between a Simon task and language control was reported.

In contrast to CN switching costs, some associations were observed for CN mixing costs. Observing significant positive associations for language mixing costs could provide tentative evidence of involvement of domain-general monitoring processes in children's language switching. This would be in line with the domain-generality framework (e.g., Green, 1998; Green & Abultalebi, 2013). Also, when considering this finding from the perspective of skill learning, Lehtonen et al. (2023) discuss that monitoring may be an EF domain where automatization does not take place, even with routinized tasks. However, the majority of the analyses here did not show a positive association between EF measures and CN for mixing costs. Thus, the evidence for the involvement of monitoring in bilingual language control was weak and inconsistent in the present study. The fact that several separate models were run for the data may increase the risk of Type I error, potentially explaining the statistically significant but inconsistent findings.

In addition to addressing the degree of association between EFs and CN, our goal was to investigate the extent to which children's everyday language control ability relies on domain-general EFs. Moreover, we studied the associations between everyday language control ability and

language control ability in the lab, which would be important for establishing ecological validity for this commonly-used lab task. For these goals, we restricted our sample to those families who provided an environment where children's demands to keep the two languages separate were high enough to assume a dual-language context. For these families, we analyzed the children's ability to follow those demands, i.e., to use a fixed language with the parent, and the extent to which that translated into the CN task in the lab, which is also assumedly simulating a dual-language context. We found no significant associations between these measures. In addition, we found only one statistically significant association between everyday language switching and EF performance, and that was in the unexpected direction. The results thus suggest that everyday language switching does not rely on domain-general EFs, at least on those functions that the lab EF tasks are measuring.

An obvious limitation is that the everyday language control analyses were performed on the subset of families (n=18) with stricter dual-language contexts, which was considerably smaller than the complete sample. This might have constrained our statistical power and hindered the possibility of finding any significant associations between everyday switching vs. CN and EF performance. Another potential question deals with the reliability and validity of parental reporting for measures on everyday switching ability and language culture in the home. These variables, obtained from parental reports, were central to understanding which families imposed dual-language context demands at home, and the extent to which children obeyed those demands, but they can be a noisy measure of language use and switching behaviors, and they can also be affected by parents' potentially negative attitudes towards language mixing between parents and children. However, parental reports have been shown to be reliable in assessing expressive vocabulary (Dale, 1991) and general language skills in children (Garibaldi et al., 2021), and some other studies have used parental reports as the only proxy for language switching in children (Kaushanskaya & Crespo, 2019; Bosma & Blom, 2019). It is therefore possible that our measure for everyday language control as reported by the parents could similarly provide dependable evidence in studying children's everyday language control ability. An additional limitation is children's performance in the Stroop task, which showed almost at ceiling performance in our sample, and may have repercussions for the results.

Reflecting on the current theoretical frameworks, our results as a whole do not support the domain-generality account that assumes that language switching engages domain-general EFs that are also used for other tasks. Even though we found some associations between the EF tasks and CN, only one of them was statistically significant and in the expected direction. We thus conclude that these results do not show consistent associations between EFs and language switching in children. While lack of associations cannot be taken as evidence to directly support any account, our results could, however, be compatible with the skill learning framework. This account predicts that EFs are not strongly involved anymore in familiar tasks that can rely on automatic subroutines stored in procedural memory. Even though it has been proposed that children, with their short bilingual experience, might not have developed such automatized subroutines yet (Lehtonen et al., 2023), the present results could suggest otherwise. The present participants were 5-7-year-old children who were overall relatively balanced in their language use, and thereby already had a few years of experience of bilingual language use. As pointed out by Lehtonen et al. (2023), it is an open question as to how much experience might be needed for automatization to take place in bilingual tasks such as language switching.

5. Conclusions

Our study adds to a limited body of research on a potential connection between children's language switching and EFs, one fundamental assumption behind the bilingual executive advantage hypothesis. In contrast to this assumption, our results indicate little involvement of EF abilities in language switching performance. Two of the five used EF measures predicted mixing costs in the CN task, suggesting the involvement of domain-general monitoring in bilingual children's language switching performance. However, only one of them was in the expected direction and statistically significant. No EF measures predicted switching costs in CN. Furthermore, our study did not find a connection between children's everyday language control ability reported by the parents and CN or EF performance in the lab. Further research with a larger sample is needed to establish the replicability of these findings. Overall, while the observed lack of associations does not provide direct evidence for any framework, the results are at odds with the view that domain-general EFs are involved in children's language switching. The skill learning account could explain the findings by assuming that early balanced bilingual children have developed task-specific skills for language switching that no longer rely on domain-general EFs.

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Article III

The skill I was learning was a crucial one, the patience to read things I could not yet understand.

– Tara Westover –

Educated

Are executive functions engaged in language switching? The role of language proficiency

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Abstract:

Bilingualism research has largely presumed that bilingual speakers engage domain-general control mechanisms in language control. This assumption is fundamental for the claim that bilinguals might train executive functions (EFs) by means of language switching. This study investigated the extent to which executive functions (EFs) are engaged in bilingual language control in a population of Finnish speakers with different degrees of Swedish language proficiency: early bilinguals, and late high-proficiency and low-proficiency learners of Swedish. Language switching was measured with a cued naming (CN) paradigm, and a Simon task was used to assess EF performance. Following the predictions of the so-called skill learning hypothesis, we expected that language switching could have become automatized and no longer rely on EFs for bilinguals with lifelong bilingual experience and those with high language proficiency, but not with those with limited language experience and lower proficiency. We thus expected to see no or weak associations between CN switching and Simon performance in the early and high-proficiency bilinguals, but the opposite with the lower proficiency participants.

As expected, our results revealed no associations between CN switching and EF control for the early bilingual and high-proficiency groups, whereas the low-proficiency group showed a CN switching–EF association. This suggests that language switching engages EFs only in participants with lower proficiency in whom these processes are not yet automatized. As the early bilinguals and high-proficiency late bilinguals showed similar effects, language proficiency might be a more important factor for bilinguals than age of acquisition in the automatization of this skill. This study questions the assumption that EFs are always required for language switching in bilinguals. If EFs are not involved in language switching in experienced bilinguals, the bilingual advantage hypothesis may also need to be reconsidered.

1. Introduction

Bilingualism research has largely presumed that bilingual speakers engage domain-general control mechanisms in language control (Bialystok, 2017, Bialystok & Craik, 2022), here called the domain-generality account. This assumption is fundamental for the claim that bilinguals might train executive functions (EFs) by means of language switching. Much of the research addressing the role of EFs in language switching has built upon the domain-generality approach by which bilingual behaviors, such as language switching, are influenced by general executive control mechanisms in a top-down manner.

A predominant model that assumes domain-general control processes for language switching is the Inhibitory Control (IC) model (Green, 1998). Under this model, both languages are co-activated at all times, and the speaker needs to inhibit the non-target language to produce a word in the desired language. For example, in unbalanced bilinguals, such as L2 speakers for whom the L1 is the dominant language, L1 needs to be strongly inhibited during production of L2. Closely connected to this model is the Adaptive Control Hypothesis (ACH) (Green & Abulatebi, 2013), which takes into account the role of the speaker's context in terms of which cognitive processes might be needed for using the appropriate language. The AC hypothesis identifies three interactional contexts: a single-language context, a dual-language context, and a dense code-switching context. In the single context, each language is often used in distinct environments, for instance work or home, but the two languages are not usually used simultaneously. In the dual context, two languages may be used within the same environment, but often with different interlocutors. An example is bilinguals who grow up speaking two languages at home, but consistently one with each parent or caregiver. In the dense code-switching context, both languages can be present in the same environment and can be used with the same interlocutor, who often is a bilingual as well. The ACH poses eight different control processes that may be involved in these contexts: goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, task engagement, and opportunistic planning. However, the different contexts do not engage the processes in the same way. The dual-language context is considered to be the most cognitively demanding one for the speaker, as it requires more constant awareness of the context in selecting the right language with the right speaker – a situation in which all eight processes are presumably engaged.

The relationship between bilingual language use and domain-general cognitive control or EFs has been a central topic in cognitive research on bilingualism. Domain-general accounts presume such an association (Bialystok, 2017; Bialystok & Craik, 2022; Green 1998; Green & Abulatebi, 2013), and have further explored whether bilingual language use, such as language switching, could *train* EFs (Bialystok, 2009; Bialystok & Viswanathan, 2012). Despite the abundance of studies reporting such bilingual advantages, this phenomenon has also been questioned, e.g., by systematic investigations and meta-analyses, e.g., de Bruin et al., 2015; Donnelly, et al., 2019; Gunnerud et al., 2020; Lehtonen et al., 2018; Lowe et al., 2021; Monnier et al., 2022; Paap et al., 2013; 2018). One might then ask whether the more fundamental assumption of bilingual language use *engaging* EFs holds.

While several studies suggest that language switching in bilinguals engages EFs due to the associations found between language switching and EF tasks in the lab (Li et al., 2021), a number of studies have also failed to find such associations (Calabria et al., 2012; 2015, Maguezi et al., 2012; see Lehtonen et al., 2023, for a review). Because the domain-generality hypothesis assumes EF-language control associations across bilingual speakers and environments, the inconsistency in these results raises the important question as to whether, and under which circumstances, bilinguals may engage domain-general control mechanisms. If associations are not consistently found, extrapolating potential training of EFs through bilingual language use might disinform our understanding of this issue.

Recent accounts have proposed alternative hypotheses as to why the research on bilingualism and EFs might show inconsistent results. The skill learning hypothesis (Chein & Schneider, 2012; Jylkkä et al., 2021; Lehtonen et al., 2023; see also Paap, 2018, for a related idea) puts forward the idea that behaviors become more automatic as practice and experience increase, and rely on EFs to a lesser extent than newly acquired skills. The idea that experience might lead to automatization, as suggested by Chein & Schneider (2012), is not specific to bilingualism, but this hypothesis has been applied recently in bilingualism research (Jylkkä et al., 2021; Lehtonen et al., 2023). The skill-learning account makes specific predictions about the conditions in which associations between EFs and language switching may be seen. First, speakers who are more experienced bilinguals, e.g., with respect to proficiency, should be less likely to engage EFs in language switching than those who are less experienced bilinguals. By extension, adult bilinguals who have

had longer experience in the use and management of two languages should be less likely to engage EFs in language control than children, whose cognition and language knowledge are still developing. Moreover, one should expect stronger associations between tasks of a similar nature and in novel tasks for which routines or skills have not yet been formed.

In practice, language switching performance can be measured in the lab using cued picture-naming tasks that can be assumed to simulate a dual-language context. In addition, cognitive tasks tapping into different components of executive control have been used to study whether associations can be found between bilingual language control and EFs. In cued naming tasks, the participant is to name a picture as quickly and correctly as possible in the language determined by a cue, such as a flag. After one or several trials, the cue changes, prompting a switch in the naming language, and this kind of language switch often elicits a processing cost. In addition to these mixed-language blocks, there are typically also single-language blocks where only one language is being used. This task allows researchers to obtain two measures for language switching: switching and mixing costs. Switching costs are obtained by comparing the difference in reaction times (RTs) between switch and repetition trials in a mixed block. Mixing costs, in turn, reflect the difference between repetition trials in mixed blocks and single trials in single blocks. One way to explain them would be to assume they reflect sustained language control processes, such as monitoring or preparedness to switch in mixed blocks, whereas such attentional demands are lower in single-block trials. Furthermore, inhibition tasks such as the Simon or Flanker tasks provide a measure for executive control. For instance, in a Simon task, the participant is asked to categorize the color of the stimulus (blue or red) using the right or left key, respectively, in a keyboard or response box. In congruent trials, the blue color appears on the right, and the red color, on the left. In incongruent trials, the colors appear in the reverse order. The Simon effect, which is used to index inhibitory control, is obtained by comparing participants' performance in incongruent versus congruent trials, with a smaller Simon effect indicating better performance.

1.1 Previous research

While the domain-generality account has been very influential, studies investigating the reliance of language switching on domain-general EFs have not consistently supported the predictions of the domain-generality hypothesis.

Jylkkä et al. (2018) examined the role EFs and language switching in a group of unbalanced bilinguals who had started learning the L2 after age 9, but who had developed high proficiency in the language. The authors found results partly challenging the IC model. However, they argued that conflict monitoring is instrumental in language switching for bilinguals. In a later study, Jylkkä et al. (2021) explored bilingual language control and domain-general cognitive control in a similar population. In this case, the authors found somewhat more consistent EF and language control associations in mixing costs than switching costs.

Studies including highly proficient bilinguals do not appear to show consistent associations between switching costs and EF performance. For instance, Branzi et al. (2016) found that for bilinguals with high proficient L2 and medium proficient L3, trilingual language switching was not predicted by a non-verbal switching task. Similar results were found for bilinguals with a lot of experience in the L2 in Magezi et al. (2012) where, again, no associations were found between language switching and non-linguistic shifting ability. Moreover, Calabria et al. (2012) reported that language control was not dependent on domain-general executive control. All in all, these results could be taken to suggest that language control is somewhat independent from general executive control, at least for speakers with significant language experience in the L2.

The studies described above suggest that bilingual language control might not be associated with domain-general EFs in bilinguals with significant amounts of experience of using the two languages. However, they are not specifically designed to test whether higher proficiency is related to smaller associations between language switching and EFs, and there are thus far very few studies that have addressed these associations in low-proficiency bilinguals. An exception is a recent study by Wang et al. (2022). Their study explored whether an association between language switching and inhibitory control, measured by means of a Simon task, could be modulated by language proficiency in Chinese L2 speakers of English. Their results showed that Simon task performance predicted switching costs in the low-proficiency group only, not in the high-proficiency group. This could be interpreted to support the skill-learning account, where the high-proficiency participants 'language switching is relatively automatized, and no longer relies on EFs, whereas for the low-proficiency group, language control is more effortful and still engages EFs. The authors interpreted this result as evidence that highly proficient bilinguals rely on domain-general control for language control less than speakers with lower L2 proficiency, a process that is representative

of the development of a second language in bilinguals. In contrast, the Simon task predicted mixing costs in the high-proficiency group. In their review, Lehtonen et al. (2023) concluded that associations between EFs and switching costs are not consistently found for proficient and balanced bilinguals. However, they also observed that associations between EFs and mixing costs are more commonly found for experienced bilinguals than with switching costs, which, according to them, might suggest that language monitoring is less likely to become an automatized process than switching.

1.2 The present study

The domain-generality account, a prominent account in bilingualism research, assumes that language switching constantly engages executive functions in dual-language contexts (Green & Abutalebi, 2013). The skill learning hypothesis, instead, assumes that EFs might not be engaged in language switching if the speaker is experienced enough in this task, and hence, this process is automatized (e.g., Lehtonen et al., 2023). This would be the case for bilinguals with lifelong experience in using and switching between these languages, and those with high proficiency in the languages, whereas EF engagement would be expected for speakers with lower proficiency in the second language (Lehtonen et al., 2023).

We tested the predictions of the skill learning hypothesis by applying a cued naming task with language switching and a Simon task in an online experiment in native speakers of Finnish with varying levels of proficiency and background in the Swedish language. We expected that the association between language switching costs and performance in this inhibitory control task would be modulated by participants' language proficiency (Lehtonen et al., 2023), and possibly by their age of acquisition (AoA) of the other language. We collected data from early bilinguals with high proficiency, for whom one would expect the greatest amount of automatization to have taken place, as well as late bilinguals with varying proficiency levels. More specifically, we expected to find 1) a positive association between cued naming switching performance and EF performance in late bilinguals with relatively low language proficiency and limited experience with language switching between Finnish and Swedish, and 2) no or weaker associations in bilingual participants with higher proficiency in the two languages and possibly earlier AoA of the other language, and who are also more experienced language switchers between Finnish and Swedish. Based on the conclusions by the Lehtonen et al. (2023) review, we expected that

proficiency would affect the EF associations for switching costs more than for mixing costs, for which associations could be observed even in high-proficiency bilinguals.

2. Method

2.1 Participants

The participants (*N*=85; mean age, 24.1; SD, 5.3; 70 women) were Finnish-speakers with varying Swedish proficiency and background (See Table 1). All participants were university students. After whole-group analyses, the participants were divided into three groups based on their age of acquisition (AoA) and language proficiency. The first group consisted of early Finnish-Swedish bilinguals (*N*=24) who had learned or been exposed to Swedish since birth or early childhood[1], before the age of 7. We used this age as a threshold since it is the age at which children begin school in Finland, which could influence their language experience if they were schooled in Swedish. Most participants in this group attended the Åbo Akademi University, a Swedish-speaking university in Turku, Finland. The second group included high-proficient native speakers of Finnish who had acquired Swedish primarily as part of the obligatory school curriculum (*N*=30; mean AoA, 11.97; SD, 1.45). The third group comprised low-proficient native Finnish-speakers who also had started to learn Swedish later in life, primarily as part of the school curriculum (*N*=31; mean AoA, 12.48; SD, 1.67) but had lower Swedish skills (see Table 2 for detailed information of the three groups). Swedish is an obligatory subject for Finnish native speakers in the national school system. Most of the participants in the high- and low-proficiency groups were following higher education at the Finnish-speaking University of Turku, Finland.

The participants' Swedish proficiency was determined by a vocabulary test (see section 2.2), which was highly correlated with their self-reported proficiency (r=0.87). Assessing a person's vocabulary knowledge has been shown to give a good insight into language proficiency for both comprehension and communicative ability (Staehr, 2008), correlating strongly with reading comprehension (Laufer & Ravenhorst-Kalovski, 2010) and with the six levels of the Common European Framework of Reference for languages (CEFR) (Milton, 2010). Moreover, we collected self-reported intentional switching data (see Table 2) to gain understanding into the participants '

[1] While there are different approaches to define "early bilingualism," (see Kremin & Byers-Heinlein, 2021) here we follow previous research that has used ages 4-7 as a threshold for early bilingual acquisition (e.g., Tao et al., 2011; van Dijk et al., 2022).

experience with switching between Finnish and Swedish. The scale ranged from 1 to 4 indicating: 0-2 times/day (rarely or never); 3–10 times/day (occasionally); 10-20 times /day (quite often); more than 20 times/day (very often). All participants in the present study also knew other languages, such as English. We excluded participants that were not neurologically healthy or reported having hearing or developmental language difficulties. The participants were recruited directly through university channels, including students who were required to participate in research as part of their coursework in psychology, via email announcements, through Swedish teachers at the University of Turku, and via social media. If the participant completed all phases of the experiment, they were asked to provide their email in order to be sent a 10-euro gift voucher (unless they were students on participation duty).

Table 1. Characteristics of the whole group of participants

Variable	**Mean (SD), *N*=86**
Age (years)	24.1 (5.3)
Swedish AoA (years)	9 (5.4)
Finnish self-rating avg	6.9 (0.02)
Swedish self-rating avg	4.5 (1.8)
Self-reported intentional switching (1-4)	1.67 (0.43)
Swedish proficiency scores (0-30)	21.2 (8.1)

Table 2. Characteristics of the three proficiency groups; mean (SD)

Variable	**EB (*n*=24)**	**HP (*n*=30)**	**LP (*n*=31)**
Age (years)	24.58 (5.92)	24.43 (5.51)	23.13 (4.02)
Swedish AoA (years)	0.75 (1.33)	11.97 (1.45)	12.48 (1.67)
Finnish self-rating avg (1-7)	6.91 (0.21)	6.98 (0.1)	6.97 (0.17)
Swedish self-rating avg (1-7)	6.7 (0.45)	4.77 (1.16)	2.85 (0.87)
Self-reported intentional switching (1-4)	2.29 (0.99)	1.58 (0.76)	1.15 (0.46)
Swedish proficiency scores (0-30)	29.13 (1.78)	24.79 (4.3)	12.26 (3.49)

Note. EB = early bilinguals; HP = high-proficiency late bilinguals; LP = low-proficiency late bilinguals

2.2 Procedure and materials

The study was approved by the Ethics Committee for Human Sciences at the University of Turku. Participants provided digital consent prior to starting the experiment, which was collected online in the Gorilla Experiment Builder (www.gorilla.sc) (Anwyl-Irvine, Massonnié, Flitton, Kirkham & Evershed, 2018). Data were collected between November 29, 2022 and February 22, 2023.

The experiment could be completed over a 1h session including breaks, or longer if the participant required longer breaks. The experiment consisted of a Simon task, a cued picture-naming language switching task, a Swedish vocabulary test, and a language background questionnaire. The vocabulary test was a short version of the Swedish Levels Test (SweLT 1.0; Bokander, 2016) that was designed to challenge even advanced learners. For the present shorter version, the creator of the test had selected items that should also work well with more moderate proficiency levels, relevant for the present purposes. Within the experiment, participants were directed into one of four groups so that the order of the naming task and the Simon task was counterbalanced. The vocabulary test and the background information were always completed after the other two tasks.

The early bilingual group was formed from those participants who had acquired both Finnish and Swedish before the age of 7 (cf. section 2.1), although most participants had acquired both languages earlier (cf. Table 2). In forming the high- and low-proficiency groups in the late-learner participants, we followed Wang et al. (2022), and used the median score in the Swedish proficiency test that had a maximum score of 30. According to this criterion, participants scoring > 18 were included in the high-proficiency group, while those scoring < 18 were included in the low-proficiency group.

The instructions of the experiment were given in Finnish. Throughout the experiment, a *memoji* acting as “experimenter” accompanied the participant through video and text explanations. In the instructions of the experiment, participants were encouraged to sit in a quiet room and wear a headset to assure the quality of oral responses. The settings of the experiment were such that participants were only allowed to sign in from a computer or a laptop, not from phones or other devices.

Cued picture naming

We designed a non-voluntary cued picture-naming task (CN) according to previous literature (Jylkkä et al. 2018; 2021) to test the participants' language switching performance. The task consisted of 7 blocks presented in a sandwich design including 2 single blocks, 3 mixed blocks, and 2 single blocks. The order in which the languages were presented was counterbalanced. Participants named pictures aloud in Finnish or Swedish, according to a visual cue of a flag. The single blocks consisted of 20 experimental items, whereas the mixed blocks presented the same pictures repeated twice (40). Practice blocks were given prior to the single blocks and the first mixed block. A total of 20 individual pictures were selected. In the mixed blocks, pictures were repeated twice.

The order of the trials was randomized in the single blocks, and pseudorandomized in the mixed blocks. The task consisted of a total of 200 trials: 80 in the single blocks and 120 in the mixed blocks. We created 4 lists for the mixed blocks to control for order effects, and to assure a sufficient number of switch trials (48; 24 to each language) and repetition trials (69). The first trial did not count as either a switch or repetition. We chose a proportion of 40% switches to 60% repetition trials to avoid predictability of the switches. We assured there were no more than 4 consecutive trials of the same type. The participants completed 5 practice trials for each of the single-language blocks and 16 practice trials before the mixed-language block. The oral responses were recorded to analyze reaction times (RT). Following Jylkkä et al. (2018; 2020), RTs were obtained by using a Matlab™ script that determined word production speed by setting the threshold for volume (percent of maximum volume in a specific audio file). We assessed different sound thresholds of the automatic script and compared them to manual word-onset timings performed by two persons. This procedure showed that 0.4 x the maximum amplitude was the most reliable threshold (with a correlation of 0.928 with manual timings) and was hence used in the determination of RTs.

The pictures were selected from the MultiPic Project (Duñabeitia et al., 2018). The words were matched across languages for mean frequency (based on the following newspaper corpora: *Turun Sanomat* for Finnish and *Göteborg-Posten* for Swedish, Laine & Virtanen, 1999) and number of alternative names. Cognates were avoided. A picture appeared in the middle of a white screen. The cue appeared slightly to the left and above the target picture. A visual cue of a flag was given in all blocks to help participants identify the target language. The cues were pseudorandomized so that there were a maximum of 4 consecutive same-language trials. Each trial lasted for a maximum

of 3 seconds. A trial began with a white screen and a fixation cross for 1500 ms fixation cross, and then the picture appeared simultaneously with a visual cue (flag denoting language). Both the cue and the picture remained on the screen for 1500 ms, regardless of when the response was produced. There was a 500 ms interval between trials. At the beginning of the task, participants watched an introduction video with audio where the "experimenter" explained what participants would do in the task, and that breaks would be possible throughout the task. While the breaks were governed by the experiment, the participant could choose the length of each break. Participants were shown a second demonstration video to display how to allow Gorilla Experient Builder to access their microphone, and they were given the opportunity to test the quality of the recording prior to starting the tasks. A familiarization phase preceded the task. Participants saw all pictures (one at a time) with both Finnish and Swedish names, followed by a reminder screen where all pictures were shown in one screen with their names in the two languages. This was particularly important for the lower proficiency speakers, who benefited from additional exposure to the words in Swedish. All instructions were given in Finnish regardless of the language block.

Simon task

A Simon task was used to measure the participants' inhibitory control ability (Simon & Rudell, 1967). Participants were asked to respond based on the color of the stimulus (red or blue) by pressing F or J, respectively, on the keyboard. The task consisted of 10 practice trials (with feedback) and 100 experimental trials. The stimuli were balanced to appear pseudorandomized at the right or left of a fixation cross. On congruent trials, the stimulus was on the same side as the response button (e.g., the blue stimulus on the right, where J is the correct response). On incongruent trials, the stimulus was on the opposite side of the response button (e.g., the blue stimulus was on the left, opposite side to the correct key, J).

Each trial began with a fixation cross of 1000 ms. After that the cue remained on the screen for 1000 ms, or until a response was given. The task provided RTs that were used to calculate the Simon effect, which is the difference between incongruent and congruent trials. The smaller the effect, the better the performance.

3. Results

All analyses were performed in R using non-linear mixed effects models (lmer, package lme4, Bates et al., 2015). For all models, log-transformed RTs was the dependent variable. In addition, we z-transformed (centered) all predictors of interest, specifically, the Simon effect measured in RTs and participants Swedish proficiency scores. For all models, trial order was always included as a covariate, and subject and item as random effects. Prior to fitting the statistical models, incorrect RTs were removed from the CN task and the Simon task. Correct trials that deviated +/- 3 SD from the participant's overall mean were also excluded. A total of 113 correct trials (0.63% of total trials) were removed. The same exclusion criteria were used for the Simon task, where 232 correct trials (2.55% of total trials) were removed. In the sections below, the estimates and standard errors are reported exponentiated.

3.1 Language control and executive control associations for the full sample

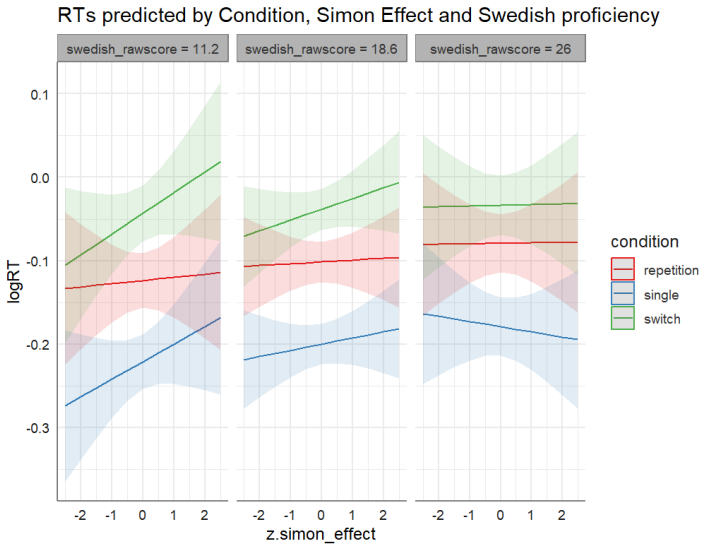
The first model assessed a three-way interaction of Condition, Simon effect and Swedish proficiency score in the full sample of participants. Figure 1 shows how in participants with a lower vocabulary score (left panel), a larger Simon effect appears to be associated with a larger switch cost. Participants with a higher vocabulary score (right panel) do not show such an effect, and the participants in the middle show a weaker association between Simon and the switch cost measure. For mixing costs, an effect, though a negative one, also seems more visible in the lower proficiency participant than in the other ones. This model revealed a close-to-significant three-way interaction for switching costs (E = 1.00, SE= 1.00, t = -1.73, p = .084) but the three-way interaction for mixing costs was not significant (E = 1.00, SE = 1.00 t = -1.63, p = .10) (exponentiated coefficients of estimates and standard errors can be seen in Table 3). The model also revealed a main effect of trial order (E = 1.00, SE = 1.00 t = -5.52, $p < .001$), which indicates that participants improved throughout the task. Furthermore, the model revealed a significant two-way interaction for switching costs and Simon effect (E = 1.03, SE = 1.00 t = 2.31, $p < .05$) for mixing costs and Simon effect (E = 1.02, SE = 1.00 t = 2.12, $p < .05$). This suggest that an increasing Simon effect increased switching costs, but decreased mixing costs. Lastly, the model showed a two-way interaction for switching costs and Swedish proficiency score (E = 1.00, SE = 1.00 t = -3.69, $p < .001$): the magnitude of switching costs increased with decreasing proficiency.

Table 3. Model analyzing Condition*Swedish Effect *Swedish Proficiency for the full sample *N* = 85

Characteristic	exp(Beta)	95% CI[1]	p-value
condition			
repetition	—	—	
single	0.91	0.90, 0.93	<0.001
switch	1.11	1.08, 1.14	<0.001
z.simon_effect	1.02	0.95, 1.09	0.5
swedish_rawscore	1.00	1.00, 1.00	0.5
trial_order_intask	1.00	1.00, 1.00	<0.001
condition * z.simon_effect			
single * z.simon_effect	1.02	1.00, 1.05	0.034
switch * z.simon_effect	1.03	1.00, 1.06	0.021
condition * swedish_rawscore			
single * swedish_rawscore	1.00	1.00, 1.00	0.2
switch * swedish_rawscore	1.00	1.00, 1.00	<0.001
z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.4
condition * z.simon_effect * swedish_rawscore			
single * z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.10
switch * z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.084

[1] CI = Confidence Interval

Figure 1. Associations between CN condition, Simon task and Swedish proficiency.



Note: RTs are log-transformed and Swedish proficiency is centered (z-transformed). *N* = 85

3.2 Language control and executive control associations for the L2 speakers

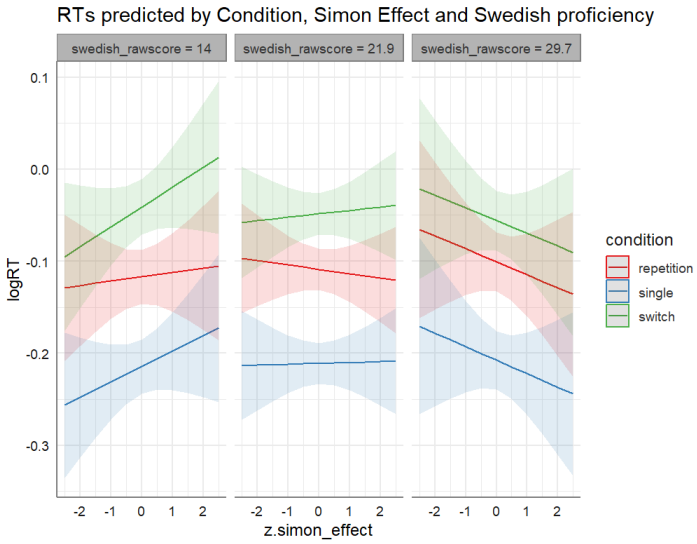
Next, we took out the early bilingual group and explored how the association between the Simon effect and CN performance might be modulated by proficiency in the late-learners. We ran a model with the three-way interaction of Condition, Simon effect and Swedish proficiency score in the group of L2 speakers, that is, those speakers who had learned Swedish after early childhood. The three-way interaction was significant for switching costs (E = 1.00, SE = 1.00, t = -1.99, p = .046) and for mixing costs (E = 1.00, SE = 1.00, t = -2.89, p < .01 (see Table 4), indicating that the magnitude of associations between language switching and inhibitory control depends on language proficiency. This model also revealed a main effect of trial order (E = 1.00, SE = 1.00, t = -5.24, p < .001) and significant interactions for switching cost and Simon effect (E = 1.04, SE = 1.01, t = 2.54, p = .01), and for switching cost and Swedish proficiency score (E = 1.00, SE = 1.00, t = -3.57, p < .001).

Table 4. Model analyzing Condition*Swedish Effect *Swedish Proficiency for the late-learner sample. *n* =61

Characteristic	exp(Beta)	95% CI[1]	p-value
condition			
repetition	—	—	
single	0.91	0.89, 0.93	<0.001
switch	1.11	1.08, 1.14	<0.001
z.simon_effect	1.01	0.94, 1.08	0.9
swedish_rawscore	1.00	1.00, 1.01	0.069
trial_order_intask	1.00	1.00, 1.00	<0.001
condition * z.simon_effect			
single * z.simon_effect	1.04	1.01, 1.06	0.002
switch * z.simon_effect	1.04	1.01, 1.07	0.011
condition * swedish_rawscore			
single * swedish_rawscore	1.00	1.00, 1.00	0.7
switch * swedish_rawscore	1.00	1.00, 1.00	<0.001
z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.9
condition * z.simon_effect * swedish_rawscore			
single * z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.004
switch * z.simon_effect * swedish_rawscore	1.00	1.00, 1.00	0.046

[1] CI = Confidence Interval

Figure 2. Associations between CN condition, Simon task and Swedish proficiency.



Note: RTs are log-transformed and Swedish proficiency is centered (z-transformed). *n* = 61

3.3. Language control and executive control associations for different proficiency groups

Finally, we analyzed the associations in the three groups separately (see sections 2.1 and 2.2 for group descriptions and criteria for division): early bilinguals, late bilinguals with higher proficiency, and late bilinguals with lower proficiency. The mean RTs and error rates for the CN and Simon tasks are reported in Table 5. In the early bilingual group, the model assessing the Simon effect on CN did not reveal a significant association for switching costs (E = 1.00, SE = .98, t = .346, p = .7), but it showed a significant negative association for mixing costs (E = 1.02, SE = 1.00, t = 2.32, p= .026). For the high-proficiency late bilinguals, the model did not reveal significant associations between Simon and switching (E = 1.00 SE = .99, t = .691, p = .5) or mixing costs (E = 1.00, SE= .99, t = -.774, p = .4). However, for the low-proficiency group, the model exploring CN associations with the Simon Task revealed significant positive associations for switching costs (E = 1.02, SE = 1.00, t = 2.48, p = .013), and negative ones for mixing costs (E = 1.02, SD = 1.00, t = 2.63, p = .009) (Figure 3; Table 6).

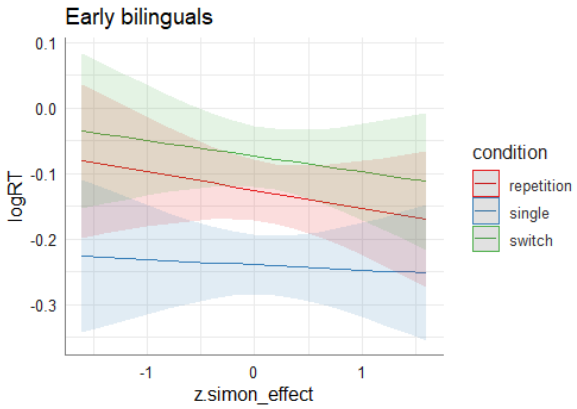
Table 5. Mean RTs in ms (SD in parenthesis) of correct trials for the CN and Simon tasks for each group, and error rates for CN. Note: CN = Cued Naming

	Mean RT CN (ms)	Error rate CN (%)	Mean RT Simon (ms)
EB	850 (16.5)	19.2	320 (17.3)
HP	890 (15.5)	26.7	290 (29.4)
LP	860 (15.7)	31.8	260 (23.4)

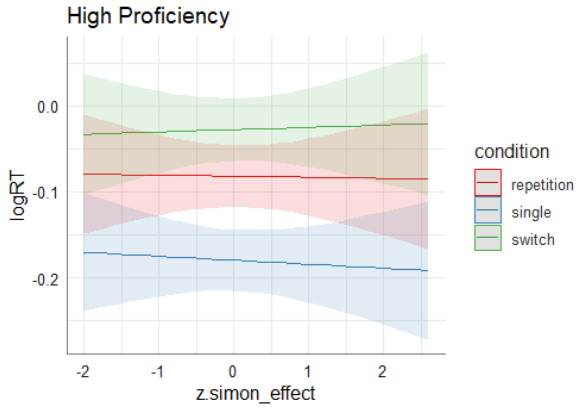
Note. EB = early bilinguals; CN = cued naming; HP = high-proficiency late bilinguals; LP = low-proficiency late bilinguals

Figure 3. Cued naming and Simon effect associations for the different proficiency groups

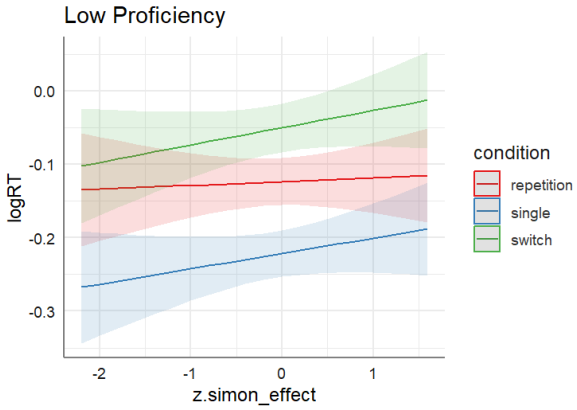
3a) Associations between Simon and CN for EB (*n*=24)



3b) Associations between Simon and CN for HP (*n*=30)



3c) Associations between Simon and CN for LP (*n*=31)



Note. EB = early bilinguals; CN = cued naming; HP = high-proficiency late bilinguals; LP = low-proficiency late bilinguals

Table 6. Estimates (standard error in parenthesis) for EF interaction effects with CN condition, including non-significant ones in the cued naming task.

Early bilingual group

Characteristic	exp(Beta)	95% CI[1]	p-value
condition			
repetition	—	—	
single	0.89	0.88, 0.90	<0.001
switch	1.05	1.04, 1.07	<0.001
z.simon_effect	0.97	0.91, 1.04	0.4
trial_order_intask	1.00	1.00, 1.00	0.032
condition * z.simon_effect			
single * z.simon_effect	1.02	1.00, 1.04	0.026
switch * z.simon_effect	1.00	0.98, 1.02	0.7

[1] CI = Confidence Interval

High-proficiency group

Characteristic	exp(Beta)	95% CI[1]	p-value
condition			
repetition	—	—	
single	0.91	0.90, 0.92	<0.001
switch	1.06	1.04, 1.07	<0.001
z.simon_effect	1.00	0.97, 1.03	>0.9
trial_order_intask	1.00	1.00, 1.00	0.014
condition * z.simon_effect			
single * z.simon_effect	1.00	0.99, 1.01	0.4
switch * z.simon_effect	1.00	0.99, 1.02	0.5

[1] CI = Confidence Interval

Low-proficiency group

Characteristic	exp(Beta)	95% CI[1]	p-value
condition			
repetition	—	—	
single	0.91	0.90, 0.92	<0.001
switch	1.08	1.06, 1.09	<0.001
z.simon_effect	1.01	0.97, 1.04	0.8
trial_order_intask	1.00	1.00, 1.00	<0.001
condition * z.simon_effect			
single * z.simon_effect	1.02	1.00, 1.03	0.009
switch * z.simon_effect	1.02	1.00, 1.03	0.013

[1] CI = Confidence Interval

Note: CN = Cued naming task

4. Discussion

In the current study, we tested the predictions of the skill learning hypothesis (Lehtonen et al., 2023) and studied whether language switching performance is associated with domain-general EF performance in participants that differ with respect to their assumed automatization of the two languages. Three groups of native Finnish speakers with different Swedish language backgrounds and proficiency levels participated in an online experiment consisting of a Simon task and a cued picture-naming language switching task, as well as a vocabulary test and background questionnaire. We predicted that an association between EF performance and the CN switching costs would be expected for participants with reduced language experience and proficiency, but no associations were expected between EF and CN switching for the more experienced and high-proficiency bilinguals. For mixing costs, associations could also be expected for higher-proficiency participants (Lehtonen et al., 2023).

The participants in the experiment were divided into three groups depending on their proficiency and experience with Swedish. The early bilingual group had acquired both languages in early childhood and hence had the longest experience of the two languages. They were also more likely than the other groups to use the two languages on a more regular daily basis (cf. Table 2 for the participant characteristics). The remaining two groups, which we categorized as high- and low-

proficiency participants, had acquired Swedish in late childhood or early adolescence. The high-proficiency group had high scores on their Swedish vocabulary test, as well as self-reported proficiency (cf. 2.1 for the correlation score between these two measures). The low-proficiency group had clearly lower Swedish vocabulary scores and self-reported proficiency. The switching frequency questions in the background form also showed that the early bilingual group and high-proficiency group were switching between Finnish and Swedish more often in their everyday lives than the low-proficiency participants (see Section 2.1 and Table 2). These more experienced participants should therefore be more likely to have developed automatic subroutines for language switching that might no longer require domain-general EFs, thus being suitable groups for testing the skill-learning account.

The regression models assessing the associations between the Simon effect and CN performance revealed no significant associations between EF and CN in the early bilingual and late high-proficiency groups, in line with the skill-learning account's predictions. For the low-proficiency group, in turn, the Simon effect positively predicted switching costs in CN, which is also consistent with this account.

The results regarding mixing costs were less clear. Mixing costs were also significantly associated with Simon performance for the low-proficiency group, but the association was in the unexpected direction. Worse performance in Simon was associated with slower RTs, particularly in the single-block trials, and less so in the repetition trials of the mixed block. A similar negative association in mixing costs was reported in the early bilingual group, but in this group, single-block performance did not seem to be as strongly associated with poorer Simon performance (Figure 3). Lehtonen et al. (2023) noted that typically clearer associations between EFs and CN are observed in mixing costs even in higher-proficiency bilinguals than switching costs, but it is difficult to draw conclusions about the currently observed negative associations.

This study is one of few investigations directly assessing the role of L2 proficiency in the association between EFs and language control (for an exception, see Wang et al., 2022), and to our knowledge, the only study exploring this relationship directly in connection to skill learning. A challenge for the currently predominant domain-generality account is the multitude of results showing no associations between EFs and language switching (e.g., Branzi et al., 2016, Calabria et al., 2012, Magezi et al., 2012), including the results observed in the present study for early and

high-proficiency late bilinguals. The skill-learning account seems to better explain these patterns. In the present study, bilingual speakers with different proficiency levels showed different results with respect to the used EF measure being able to predict switching costs in CN. While we predicted that greater bilingual experience should, at best, lead to very weak associations between EF and CN switching, the exact quantity or quality of language experience necessary for EF involvement to diminish is not currently specified in the skill-learning account, nor was it in our predictions. The data in our study are also insufficient to determine the exact degree of language experience or level of proficiency required for speakers to no longer engage EFs.

Our results nevertheless revealed noteworthy findings with respect to the more proficient speakers, that is, the early bilingual and the high-proficiency groups, in both of which we found no associations in switching costs. In our study, the late high-proficiency group was quite similar to the early bilinguals in terms of Swedish proficiency based on the vocabulary test, AoA being the most apparent difference between these two groups. In view of this result, while AoA might be an important indicator of a bilingual's cumulative length of exposure to their languages, it does not seem to be the only factor that influences the extent to which speakers are able to automatize language behaviors such as language switching. Purely based on our division of groups, L2 proficiency seems to be a more important factor driving the EF-language control associations.

Nevertheless, it is worth discussing some key aspects with respect to the background differences and similarities across groups. First, the early bilingual and the high-proficiency late bilingual groups are very similar with respect to the assessed proficiency, also the latter group scoring quite high in the Swedish vocabulary test. Second, the age of acquisition for the high-proficiency late bilingual group is later than for the early bilingual group, but the speakers in the high-proficiency group had still started acquiring Swedish at a fairly young age (mean AoA= 11.97 for the high-proficiency group; mean AoA= 12.48 for the low-proficiency group), providing them with over a decade of bilingual experience by the time of the testing. This again taps into the question of how rapidly cognitive behaviors can become automatized, especially if acquired during a life period with still significant cognitive maturation, such as in adolescence. Third, the low-proficiency group had started acquiring Swedish around the same time as the late high-proficiency group, yet they show strikingly different results as compared to the high-proficiency group. Based on this finding,

age of acquisition and its length could be inferred to be a less relevant factor compared to language proficiency.

This study also presents some limitations, such as the extent to which these different groups diverge or converge in their daily use of Swedish, and how this may play a role in the engagement of EFs. While we have some information about the current daily use of these languages and the degree to which the participants switch in their day-to-day life, we lack information as to potential changes of these behaviors across the lifespan, and how that might influence their cumulative exposure. An additional potential limitation is the online nature of the experiment used for data collection, and whether the data retain the same degree of reliability as lab-collected data. However, in a recent study, Uittenhove et al. (2023) showed that the modality of testing has little impact on data quality. Nevertheless, they highlighted that the participant pool one might have access to through recruitment platforms such as Prolific or MTurk may limit researchers' access to variability in the sample that is sufficiently representative of the population of interest. In our study, however, participants were recruited directly through university channels and Swedish-speaking environments, in the same way one would recruit participants for lab-testing. Therefore, we do not consider this aspect to be a major concern in our study.

This investigation is one of the first to assess the role of L2 proficiency in the relationship between EFs and language control and to test the skill learning hypothesis. Further research is needed to understand the extent to which L2 proficiency influences the relationship between EFs and bilingual language control, especially with respect to mixing cost measures, as well as the specific quantity of L2 experience necessary for automatization to take place in switching. Nevertheless, the current results can be taken to challenge the widely established assumption that EFs are always involved in language switching. These results may then cast doubt on the cognitive training hypothesis, as well. If the engagement of EFs for language control is limited to a specific group of speakers, the idea that all bilingualism could train domain-general cognitive processes needs to be reconsidered.

5. Conclusion

We explored associations between performance in a cued picture-naming task with language switching and a Simon task in a sample of Finnish-Swedish bilinguals and language learners in Finland with different proficiency levels. Our results indicate that reached proficiency level is an

important factor in determining the extent to which the speaker engages EFs in their bilingual language control. For high-proficiency bilinguals, the substantial experience they have gathered in language switching and use might have led them to develop specialized subroutines or skills for language switching that no longer rely on EFs. Instead, for L2-speakers in the early stages of learning who have less bilingual experience, language switching is not likely to have yet become an automatized cognitive process. The inconsistencies in the mixing cost results require further investigation.

On a broader level, these results may contribute to the bilingual advantage debate, as they challenge the domain-generality view, which assumes that executive control is necessary for language switching in dual-language contexts, and by extension the cognitive training hypothesis and the bilingual advantage debate. If EF engagement is limited to a reduced proportion of bilingual speakers, it is unlikely that language switching can generally train EFs across bilinguals.

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But for me, there was the hope that writing this book would allow me to discover my own personal standard. I'm not very confident that I've done a good job in this area. Still, when finished, I had the feeling that a weight had been lifted. (I think it may have been just the right moment to write this book when I did).

– Haruki Murakami –

What I talk about when I talk about running