Patterns of Parent-Child Code-Switching and Links to Child Language Development

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Abstract

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Many bilingual families code-switch (e.g., switch from one language to another) in natural environments, but little is known about its role in language acquisition or the relationship between child and caregiver code-switching. This study identified instances of code-switching (CS) in 23 23- to 36-month-old Spanish-English bilingual toddlers and their caregivers using Language ENvironment Analysis (LENA) audio-recordings during their daily interactions, then investigated the interval frequency of CS occurrence and how it was related to children's Macarthur-Bates Communicative Developmental Inventory (M-CDI) vocabulary as well as word learning skills. Multiple linear regression models were used to investigate associations between M-CDI vocabulary (English, Spanish, and combined) and children's age, Language Exposure Assessment Tool (LEAT) scores, child CS, mother CS, and father CS. The same factors were used to investigate associations with word learning skills (English, Spanish, and combined). Interval frequency of CS was highly variable, with a significant correlation between children and fathers' code-switching. For the English M-CDI, LEAT scores, child CS, and mother CS were significant factors; child CS was the significant factor for the Spanish and combined M-CDIs. Child CS was also the significant factor for English word learning. Results emphasize the importance of children's CS in language development. In contrast to historical perceptions of CS as a sign of linguistic confusion, findings suggest that CS is an indication of linguistic mastery.

Children learning more than one language often hear language input that is combined or mixed during conversations, a phenomenon known as code-switching (CS). Evidence suggests that the combination of input in both languages plays an important role in bilingual language outcomes. While various studies have affirmed the importance and positive impact of bilingual exposure in multilingual families (Liberman et al., 2017; Méndez et al., 2015; Oh & Fuligni, 2010), fewer have qualified the effects of bilingual CS on language development. Fewer still have explored the way that toddlers at the early stages of emerging language (2-3 years old) engage in CS during conversations with caregivers. The purpose of this thesis is to examine language exchanges between toddlers and caregivers to determine whether child CS is correlated to other communication partners (e.g., whether child CS significantly correlates to caregiver CS) and whether CS frequencies are related to child bilingual vocabulary development and word learning skills.

In this thesis, CS is operationalized as one individual speaking in one language and then switching to another language regardless of whether the language switch was from Spanish to English or English to Spanish. In the current CS literature, CS is typically divided into two broad types; inter-sentential CS refers to instances of language switching that occur in separate utterances whereas intra-sentential CS refers to instances of language switching that occur within the same utterance. Both inter-sentential and intra-sentential CS were considered for this thesis. This definition was based on prior research using natural audio recordings to analyze CS (Cychosz et al., 2021; Kremin et al., 2022).

Conceptually, this thesis tracked each individual's language switching (CS) because the primary research questions sought to distinctly identify each individual's use of language rather than the overall exposure a child had to CS across multiple language sources. Rather than counting every instance of CS, this study sought to quantify CS in a more binary approach by qualifying whether intra-sentential or inter-sentential CS occurred at least once during each 30-second interval that was analyzed. This differed from Kremin et al. (2022), as they utilized a manual approach to identify the true frequency of CS, identifying every single time an intra-sentential or inter-sentential instance of CS occurred across the entirety of their audio recordings. In other words, this study utilized interval sampling rather than continuous event sampling. Our approach was utilized to simplify the coding process and offer a broader starting point for future work.

The primary purpose of this thesis was to examine parent and child use of code-switching during daily interactions and investigate how code-switching is related to children's bilingual vocabulary and word learning skills. The remainder of the introduction will review: 1) historical context; 2) methodological factors; 3) caregiver code-switching; 4) children's patterns of CS in development; and 5) the role of CS in bilingual acquisition, focusing on children's vocabulary development and word learning.

Historical Perspectives on Code Switching

Historically, the academic language used to describe CS (e.g., "linguistic confusion", "interference") has also inherently framed CS as undesirable or problematic. One traditional approach known as One Parent One Language (OPOL) encouraged caregivers to use only their native language when speaking to their child, effectively having one parent responsible for the "majority" language and one parent responsible for the "minority" or heritage language (Ronjat, 2013). In the words of Goodz (1989) who does not personally endorse OPOL, "it is often assumed that linguistic confusion resulting from early simultaneous exposure to two languages can be minimized, or even eliminated, if parents follow the Grammont principle of maintaining a strict parent-language separation" (p. 41). In reality, many parents committed to the OPOL approach tended to code switch when speaking to their children (Goodz, 1989); in other words, natural bilingual caregiver language output appears to include CS. While OPOL does not appear to be explicitly harmful and may provide some benefits (Pauwels, 2005), Genesee (1989) and Vihman (1985) found that children are typically capable of distinguishing between languages and de Houwer (2007) concluded that having both parents use the "minority"/heritage language could be supportive for heritage language retention.

More recently, Knouse et al. (2022) found that in upstate South Carolina, an area with rapid Latine population growth over the past decades, the majority of Latine community members who participated in their study had a neutral outlook or negative bias against CS. In other words, the perspective that code-switching could negatively influence language is deeply ingrained. In the UK, Wilson (2021) found that even French-English caregivers who valued bilingualism and heritage language retention and had neutral-positive attitudes towards CS did not necessarily use CS at home. This suggests that even in the best case scenario with an arguably less socially stigmatized heritage language and positive caregiver attitude towards bilingualism and CS, caregivers may be conflicted as to whether they should actually implement CS. Whereas overall bilingual literature has academically affirmed the sociocultural value of bilingualism and subsequently advocated for multilingual individuals to retain heritage language(s) and engage with their community, the longstanding history of direct and indirect discrimination has likely influenced implicit and explicit bias against CS.

Contrary to the negative bias associated with CS, research has shown several positive outcomes beyond the obvious linguistic (e.g., knowing multiple languages) or sociocultural benefits (e.g., connecting to community). Indeed, growing evidence suggests that CS is not a factor that negatively impacts bilingual language development (Place & Hoff, 2016). Rather, CS is natural, frequent, used for many different reasons, and may support bilingual development. Given the potential for CS to provide important information about bilingual trajectories, more specific research is needed.

Methodological Considerations in CS Research

There are several methodological challenges that arise with research on code-switching such as quantifying the amount of CS children experience and collecting ecologically valid samples. The amount of bilingual input that children receive has traditionally been measured with caregiver-report. These instruments tend to ask for a global percentage or a daily/hourly breakdown of the quantity each language is spoken by primary caregivers using a categorical rating scale to roughly estimate relative proportion of each language spoken to a child. However, this methodology can be inaccurate and lacks specificity about the quality and content of language input (Bail et al., 2015; Place & Hoff, 2016). Moreover, it does not provide any meaningful data about the extent of language mixing during daily interactions. Another challenge centers on collecting ecologically valid samples of code-switching that reflect natural and daily use. One potential solution is collecting daylong naturalistic recordings on wearable devices (e.g., Language ENvironment Analysis; LENA; Ford et. al, 2008). This method may provide more accurate estimates of language input in bilingual contexts (Orena et al., 2020). Finally, most research on CS has focused on western language pairs. Although the current study focuses on children learning Spanish and English, we hope that the methodologies may be applied to support future investigations between new language pairs.

Code-Switching in Caregiver Input

Caregiver code-switching to their children occurs across many varied scenarios; it can happen in informal and formal contexts, with primary caregivers or others, and in more active play or more casual conversation, to name a few. Fully capturing the richness of code-switching dynamics is a formidable task. Conversely, most research has relied on case studies, short interactions, or experimental paradigms to measure and analyze code-switching. Earlier case studies such as Goodz (1989), Lanza (1992), Meng & Miyamoto (2012), Mishina (1999), Mishina-Mori (2011), and Walla (2017) relied on longitudinal, in-person, researcher observations of a family, and occasional direct researcher-child interactions (Mishina, 1999; Mishina-Mori, 2011). Methodology typically involved manual transcription of several hours of audio-recorded data and calculated frequency of CS [with the exceptions of Goodz (1989) and Lanza (1992)]. Results from these early studies revealed three key findings: parents tended to code switch around 5% of the time (range: 0 - 9.8%), with monolingual caregivers occasionally code-switching as well (range: 0 - 2%; Mishina, 1999; Mishina-Mori, 2011); CS was influenced not only by parents' choices, but also children's own use; and patterns of CS (in children and adults) were influenced by the sociolinguistic context.

In addition to small sample sizes, early case studies were based on highly heterogeneous participants that varied in age, societal language context, and caregiver language background, making comparison and interpretation of results more challenging. In Mishina (1999), for instance, 1 bilingual Japanese-English and 1 monolingual English caregiver in an English-speaking community claimed to use the OPOL strategy with their child between the ages of 1;10 and 2;2. Both parents code-switched, with the bilingual caregiver code-switching more frequently. Goodz (1989) studied 4 Canadian French-English bilingual subjects longitudinally from various intervals between the ages of 1;2 and 4;3 whose parents were committed to the

OPOL strategy. Each parent was a native speaker of their respective language but still used CS on occasion. Findings showed that parental CS was typically in response to their child's CS and that parents' overall CS increased with the child's age. Lanza (1992) featured a single subject between 2;0 and 2;7 whose two bilingual parents primarily spoke English in a Norwegian-dominant society. She observed that their child demonstrated contextual sensitivity by adjusting her speech output to English when conversing with her mother who used frequent "corrective" monolingual-oriented English cues (e.g., responding in English to CS utterances, asking clarifying questions in English) relative to the more neutral or bilingual-oriented contextual responses from the other caregiver. This occurred despite the child's relative language dominance in Norwegian. In a later study by Mishina-Mori (2011), 2 children from separate Japanese-English bilingual households in an English-speaking community with parents who adhered to the OPOL strategy were followed longitudinally (one child was between ages 2;3 – 3;2 and the other subject was between ages 2;5 – 3;3). In this environment, the researcher observed a similar phenomenon wherein parental responses to child CS (e.g., the extent to which parents "allowed" child CS to occur) influenced children's CS patterns.

Other contexts suggest that CS may be more prevalent than these case studies capture. For instance, shorter experimental paradigms or shorter interactions such as an observed 13-minute play session between a mother-child dyad at 18- to 24-months-old, revealed code-switching rates of around 15% (Bail et al., 2015). This study design included 24 subjects, notably higher than the 1-4 subjects featured in case studies, but still observed that CS rates were highly variable among subjects. One limitation of the existing research with larger sample sizes is the unnatural, unfamiliar laboratory environment and the shorter interaction time. The introduction of new technology such as Language ENvironment Analysis (LENA) provides the opportunity to investigate CS in naturalistic environments without the presence of researchers.

Capturing CS through Naturalistic Recordings

The LENA system includes a small wearable digital audio recorder and patented software used to collect up to 16 hours of continuous speech data near a target child (within 5 feet). It also automatically segments data into categories such as adult word count (AWC), child vocalization count (CVC), and conversational turn counts (CTC). To date, this methodology has been used in many studies related to natural child language development because it is subtle, relatively easy to implement and explain to participants, and does not necessitate caregivers visiting a laboratory or researchers physically going to families' homes (Ma et al., 2021; Orena et al., 2019; Wood et al., 2016).

Although there are many potential benefits, there are also challenges with applying the technology to non-English or bilingual contexts. Firstly, the patented LENA software was normed to analyze North American English and did not purposefully include other languages or bilingual data, putting the validity of these automated measures into some question. In a meta-analysis of 28 studies that reported on the accuracy of LENA's system labels or metrics including subjects that differed from the normed sample (e.g., 15 studies with non-North American English including several languages outside of English, suspected or diagnosed Autistic children, low SES, preterm birth, twins, particularly high in language skills, bilingual upbringing, at risk for developmental delays, or a combination), there were strong correlations for Adult Word Count (AWC) (mean $r = .79$; $n = 13$) and a similarly high correlation for Child Vocalization Count (CVC) (mean $r = .77$; $n = 5$) but relatively weak correlations for CTC ($r = .36$, on $N = 6$) (Cristia et al., 2020a). In another study with 38 Korean children between the ages

0;7 and 1;6, AWC accuracy was also about equivalent to values from the meta-analysis by Cristia et al. (2020a), though the CVC accuracy was notably lower to match that of other non-European languages (McDonald et al., 2021). Orena et al. (2019) investigated AWC in 20 10-month-old French-English Canadian families and noted that there was a high 85% correlation between LENA and manual transcription, but similarly underestimated LENA AWC counts; however, there was notably no significant difference between different languages.

Cristia et al. (2020b) followed up their prior work to investigate 3 corpora with normed populations, 1 corpus with a different dialect of English, and 1 corpus made of a completely different population (e.g., rural, different language, large families, multiple children present) and utilized completely random segment/interval selection in contrast to using measures like AWC to determine target selections. They found reasonable accuracy of AWC and CVC across subjects who were both linguistically similar and different from the original normed LENA sample. However, they also noted less accurate CTC values and diminished sensitivity to more masculine adult voices and non-target children. A validation study by Marchman et al. (2021) with 104 Spanish-speaking dyads at ages 1;7 and 2;2 found moderate associations but large absolute differences between transcriber-LENA AWC; additionally, they found weak associations between transcriber-LENA CVC. Keeping all studies in mind, there is evidence to suggest that AWC counts are typically underestimated but at least moderately correlated with values that manual transcription would provide across different language contexts. While bilingual research is limited, LENA automated metrics could serve as reasonable estimate or starting point for future research.

Universally, initial studies using traditional recording and coding methodologies primarily focused on caregiver input and largely excluded analysis of the child’s own CS production during conversations with caregivers. The LENA system also provides an opportunity to learn more about how children are code-switching and how their own CS may be associated with caregivers.

Code-Switching in Child Language Production

With daylong audio recordings, we can investigate not only adult input, but also child use. The child plays an important role in conversations with caregivers. While the exact developmental timeline of code-switching production in young children is unknown, several studies have identified that both monolingual (Werker & Tees, 1984; Kuhl et al., 1992) and bilingual (Bosch & Sebastián-Gallés, 1997) infants are sensitive to their native language's phonemes *and* are tuning into the prosody and other extralinguistic features of the languages in their auditory environment (Abboub et al., 2016; Gervain & Werker, 2013; Jusczyk et al., 1993; Puccini et al., 2010) within one year of birth. There is evidence to suggest that bilingual infants attend to both languages as early as 4-months-old (Bosch & Sebastián-Gallés, 2001). Within the first two years, many early signs of meaningful language differentiation emerge. As early as 12-months-old, Quay (1995) observed a child's production of bilingual translation equivalents, or using the correct label for an object in both of the subject's languages, which continued to increase throughout the duration of the study (e.g., birth to 22-months-old) and was corroborated by language-differentiating evidence in children from 14-months-old (Vihman, 1985) and 22- to 34-months-old (Genesee et al., 1995).

Several studies have identified that children build skills that support bilingual communication between 24- and 36-months-old. For example, multiple case studies found evidence of code-switching between 22- and 26-months-old (Genesee et al., 1995; Lanza, 1992; Meng and Miyamoto, 2012; Mishina, 1999; Mishina-Mori, 2011). Lanza (1992) specifically noted code-switching at the 1-to-2-word level at 24-months-old and in multi-word utterances by 31-months-old. When it comes to frequency, Ribot and Hoff (2014) found that more than half of participants code-switched in a sample of 115 30-month-old Spanish-English children. The exact ratio, between 55-70%, was suggested to differ depending on the child's language background, hypothesized to be related to the dominant societal language (Lanza, 1992; Walla, 2017) and/or the language(s) that the person speaking to them uses (Meng & Miyamoto, 2012; Mishina, 1999; Mishina-Mori, 2011). For instance, Walla (2017) observed that a bilingual Norwegian-English child between the ages of 2;3 and 3;3 primarily code-switched based on her Norwegian language dominance; in other words, she code-switched frequently from English to Norwegian but rarely from Norwegian to English.

Larger implications for how bilingual children code-switch under 3 years old are understudied. There is evidence to suggest that children mostly adhere to predictable grammar-like rules (de Houwer, 1990; Genesee, 1989; Meisel, 1994; Paradis et al., 2000; Vihman, 1985). For instance, in a longitudinal study of 15 French-English bilingual children between the ages of 2;3 and 3;6 (Paradis et al., 2000), participants acquired morphemes in a predictable order in each of their languages and produced them appropriately according to each language. Beyond grammar, in another longitudinal study of 3 German-English bilingual children from 2;3-3;11, code-switched utterances had higher MLU at all timepoints and increased with age, a sign of more complex language (Quick et al., 2018). Higher MLU is generally perceived as a sign of more complex language, and Quick et al. (2018) found that code-switched utterances were longer and contained longer phrases and sentences than non-CS utterances.

Given contrasting evidence for developmental implications of CS in children under three, additional research is needed to describe CS trajectories in children but also to explore factors that may influence children's CS such as adult input and dyadic interaction. While it may be logical to assume that caregiver input is the most important factor in child CS frequency, how frequently each child code-switches was much more variable and unpredictable than the likelihood that a child would code-switch in the first place. The "modeling hypothesis" coined by Comeau et al. (2003) hypothesized that parental CS input frequency would directly correlate with child output CS frequency. In several direct researcher observations in the home (Meng and Miyamoto, 2012; Mishina, 1999; Mishina-Mori, 2011), studies observed a pattern of increased overall frequency and range of CS in child output relative to adult input. Meng and Miyamoto (2012) found 59% CS in child output in contrast to adult input of 5%. Mishina (1999) noted that the child code-switched between 0 and 45.5% of the time across different time points relative to the bilingual caregiver's 1.3 - 9.8% frequency; additionally, the child code-switched between 5.6 and 9.9% of the time across various time points relative to their monolingual caregiver's 0 – 2% frequency. In a study by Mishina-Mori (2011) with two different subjects, subject 1 code-switched 48.9% of the time to their bilingual parents and 0.5% to their monolingual parent while their bilingual parent provided 2.1% CS input and their monolingual parent provided 0.1% CS input. Interestingly, subject 2 code-switched 0.9% to their bilingual caregiver and 3.3% to their monolingual caregiver who both provided CS input of 0.3% to their child. Existing research suggests that overall frequency is not purely influenced by input, though investigating beyond the case study restraints of 1-2 subjects is important to make any claims. These papers ultimately do not directly support the "modeling hypothesis".

While input frequency may not directly correspond with output frequency (Bail, 2015), there is evidence to suggest that parental interaction still affects child output. Observations from studies by Lanza (1992), Mishina-Mori (2011), and Goodz (1989) demonstrated how children change their CS habits based on caregiver approval of their CS. For example, the parents in Lanza (1992) explicitly responded to their child's CS with just English or asked clarifying questions solely in English; over time, this resulted in the child using more English (i.e., less CS) with that caregiver. Beyond caregiver speech acts, Comeau et al. (2003) found that children would modulate their CS frequency in response to a research assistant purposefully adjusting their frequency of CS input. All 6 subjects significantly increased their CS frequency in response to researchers providing higher frequency CS input; in a final condition with lower CS frequency again, there was an overall significant decrease in children's CS output frequency. Some children demonstrated a near equivalent rate of mixing to the assistant, but others demonstrated higher or lesser frequency of CS relative to the assistant, suggesting that there are other factors at play. CS does not appear to be completely random or based solely on the lack of language skills in one language; colloquially, it does not seem like an inherently bad sign. Ultimately, there is not extensive evidence on how language development correlates with CS under three-years-old.

Code Switching in Children over 5 is Associated with Bilingual Proficiency

Whereas there is limited research available for children under 5-years-old, there are promising, emerging studies of older children suggesting that code-switching is a sign of linguistic complexity. Kaushanskaya & Crespo (2019) found that children 5- to 11-years old with higher working memory scores benefited from code-switching input while children with lower working memory scores were negatively impacted by code-switching input. Neutral effects were observed in the context of bilingual AAC where age and processing speed but not code-switching impacted acquisition (King, 2019). On the positive end, Yow et al. (2018) found that in a study of Mandarin-English bilingual 5- to 6-year-old children in Singaporean school settings, where multilingualism is the norm, more code-switching was correlated with higher

Mandarin and English competencies overall; additionally, the cohort's less proficient language was Mandarin, but they demonstrated stronger relative expressive Mandarin vocabulary. While there are clearly mixed results, it also appears that there is an age gap in the studies that showed positive vs. negative language outcomes that must be explored.

Role in Bilingual Acquisition: Links to Bilingual Word Learning

The role of code-switching in bilingual language acquisition has mixed results from positive, neutral, and negative, though overall it appears more neutral-to-negative among younger children and neutral-to-positive for older children. Most of the existing research focuses on the effects of CS on language development (Bail et al., 2015; Byers-Heinlein, 2013; Byers-Heinlein et al., 2022; Guevara, 2020; Kaushanskaya et al., 2023; Yow et al., 2018), whereas other studies focus on cognition (Kaushanskaya & Crespo, 2019; King, 2019; Sun et al., 2020). Neutral effects, for instance, were observed in a short 15-minute laboratory play setting with caregiver-child dyads (Bail et al., 2015). In this study, children between 17- and 24-months-old were provided specific toys selected to avoid cognates. Caregivers' utterances with inter-sentential CS (between sentences; "¿Qué es esto? Doggie") were correlated with overall vocabulary, whereas utterances with intra-sentential CS (within sentences; "El doggie") were not (Bail et al., 2015). Results suggest that certain types of CS may be more supportive to word learning than others. Beyond CS, other language features may influence the success of word-learning. In a laboratory study by Potter et al. (2019) also found that 20 bilingual Spanish-English 18- to 30-month-old toddlers showed stronger word-learning skills when they were introduced to the novel word in their dominant language, regardless of whether it was introduced in a code-switched or same-language context. Even within the greater category of code-switched utterances, it is likely that careful consideration of environmental language factors is also critical when interpreting results. Together, these studies show that CS, especially at this young age, may lead to mixed results considering the strong influence of external factors and, potentially, general patterns of bilingual development.

Other research has documented negative correlations between parent CS and child language outcomes. For instance, Byers-Heinlein (2013) found that higher parent-reported CS exposure led to significantly smaller English receptive vocabulary in 1½-year-old bilingual children and marginally smaller English vocabularies in 2-year-old bilingual children. This study relied solely on parent-reported CS amounts and only accounted for correlations to English vocabulary, so it may have not accounted for the total language skills of the children in the study. It appears that CS may have some potential negative correlations to vocabulary, though it is hard to separate whether this is due to the CS alone or other factors such as the use of only English vocabulary in the methodology. Additionally, even this gap in vocabulary appears to decrease over the relatively short period of 6 months. Guevara (2020) observed that bilingual Spanish-English children ages 2;6-3;8 showed a significant negative correlation between increased code-switching and receptive Spanish vocabulary as measured by the standardized Test de Vocabulario en Imagenes Peabody (TVIP), though it is worth noting that the study took place in a laboratory environment, caregivers were explicitly instructed to follow an OPOL approach, and audio recordings were halted after roughly 100 segments/intervals were collected. Byers-Heinlein et al. (2022) investigated novel word learning using eye-tracking in the context of code-switched sentences with 3½-year-old participants and found negative effects. In this study, participants learned novel words in either a same-language condition or CS condition. Of note, in the CS condition, the novel word was not the word that was code-switched (e.g., transformed to have phonemic characteristics of the other language such as “do you see the *chien* [french] on the teelo [novel word with English-like qualities]?"). Using this methodology, French-English bilingual children only recognized the novel word in same-language conditions whereas Spanish-English children did not recognize the novel word in either condition. This suggests that the specific language combination of a bilingual child may be relevant. Considering that the Spanish-English bilingual children did not recognize the word in either condition, it appears that CS alone may not have been the factor that made word learning in this structured laboratory setting particularly difficult.

In contrast, a study of 45 Spanish-English bilingual children in a lab setting discovered that 5-year-olds who learned novel words in a code-switched format, including teaching until the learning criteria was met, required fewer exposures to the novel word (Kaushanskaya, 2023). This effect was not influenced by language ability or amount of CS exposure, suggesting that neutral-negative effects of CS observed in younger children may skew towards neutral-positive with age. One potential explanation for the differences identified in studies with children under 3-years-old and studies with children over 3-years-old may be due to natural bilingual language development, the difficulty of replicating natural CS in a lab setting, and specific study designs. Regarding study designs, many used technology to capture children's behavioral responses to CS (e.g., eye-tracking; Byers-Heinlein et al., 2017, 2022). While these are valid methods, they rely on toddlers attending to the task. Some studies of younger bilingual children have shown additional processing costs when CS is primarily in their non-dominant language (Potter et al., 2019), which is logical considering that most bilinguals do not have perfectly balanced language competence in both languages. Results may also be influenced by attending formal schooling which is more likely for older bilingual children. In addition, younger bilingual children may not be exposed to bilingual input from such a large variety of sources. Overall, in contrast to the neutral-negative results of studies with younger children, slightly older simultaneous bilinguals showing positive results suggesting that the research is inconsistent and may need to seriously consider change over time to accurately measure the impact of CS in language development. Additional evidence is needed to determine whether children's and caregivers' use of CS is associated with word learning, but early evidence suggests that there may be a steeper initial learning curve, or higher opportunity cost, that later results in benefits to overall bilingual language development.

The Present Study

The present study aims to build on the existing literature in several ways. First, we will use daylong recordings (i.e., LENA) to provide a more naturalistic account of CS in bilingual homes; second, we will evaluate both caregiver and child use of CS in daily interactions; third we will explore the association between caregiver and children's use of CS in daily interactions with children's vocabulary development and word learning. We ask the following research questions:

Research Questions

1. What is the frequency of code-switching (in caregiver input and in child's use) in everyday conversations between bilingual children and their primary caregivers (mother and father); furthermore, is the frequency of caregiver code-switching correlated with the frequency of child code-switching?
2. Is the frequency of code-switching (child and caregivers) associated with children's English, Spanish, and/or combined vocabulary?
3. How is code-switching (child and caregivers) related to children's word learning skills in English, Spanish, or combined word learning skills?

Methods

Participants

The present study includes a final sample of 23 children between 23 and 36 months. Participant demographics are presented in Table 1. Data were collected as part of a larger longitudinal study investigating bilingual development in dual language learners. All children were acquiring both Spanish and English (at least 5% in each language as judged by LEAT exposure scores). LEAT Spanish exposure (M = 0.59, SD = 0.20) was significantly higher than LEAT English exposure (M = 0.41, SD = 0.20) in this sample ($p = .005$). Children with a range of language skills were recruited including those with typically developing language, those with documented language delays ($n = 2$), and those whose parents had concerns about language development (English: $n = 3$; Spanish: $n = 6$). Children with known diagnosed neurodevelopmental disorders at the time of recruitment were excluded (e.g., Autism Spectrum Disorder, Down Syndrome, etc.). All consent forms and informational flyers were translated into Spanish.

Assessments and Materials

Demographic and Language Environment Questionnaire

During the home visit, participants completed comprehensive questionnaires that collected demographic information and information about the home language environment. Demographic questions included items about family socioeconomic status (e.g., income, level of education, and occupation for both parents), parent and child race and ethnicity, and details about the parents' and child's birth country and immigration history. Additional data was collected on the home language environment including: the child's general language development, household membership, primary caregivers, languages spoken to and by siblings and other caregivers, languages spoken in the home, language exposure during childcare, preschool, media and screen time and the frequency and languages used when reading books to the child. The Language Exposure Assessment Tool (LEAT; DeAnda et al., 2016) was also implemented through an interview format to collect data on the number of hours per week caregivers used each language (Spanish and English) with the child. All surveys were administered in the language parents felt most comfortable speaking (Spanish or English).

Macarthur-Bates Communicative Developmental Inventory

The M-CDIs are parent report instruments which capture important information about children's developing abilities in early language, including vocabulary comprehension, production, gestures, and grammar. The English CDI: Words & Sentences form (Fenson, 2007) and Spanish Palabras y Enunciados (Words & Sentences; Jackson-Maldonado et. al, 1992) form were used in this study. Both forms are normed for children aged 18- to 30-months-old. Caregivers are presented with a checklist of vocabulary words and are asked to indicate which words their child produces; they are also asked to recall three of their child's longest utterances. It is important to note that these instruments are normed on monolingual speakers of English and Spanish under 30 months, so normative data is not presented. Rather, we present raw vocabulary scores and use raw scores in all analyses.

For this study, raw English M-CDI vocabulary scores, raw Spanish M-CDI vocabulary scores, and combined English and Spanish vocabulary scores were used for analyses. Combined English and Spanish vocabulary scores were considered, as extensive literature cites that adding the vocabulary from both languages a bilingual child knows tends to more accurately represent their skills (Hoff et al., 2012). For this study, raw English M-CDI and Spanish M-CDI vocabulary scores were added to create combined raw English and Spanish M-CDI scores for analysis. The M-CDIs were chosen to measure vocabulary because of their standardization, simple administration, and extensive usage in prior infant research.

Word Learning Task

The word-learning task was a classic fast-mapping paradigm (Kan & Kohnert, 2008; Markman & Wachtel, 1988) wherein a child was trained on two items with novel labels, asked to identify one of the items, and then scored based on their demonstrated comprehension of the novel label-to-item association. The task was administrated in the child's familiar environment, typically the family home. Researchers presented the task in 2 separate blocks (1 in Spanish and 1 in English). One parent, typically the mother, was present to physically support the child (e.g., holding them on their lap), while the researcher was physically across from the dyad within arm's reach. In between the parent-child dyad and the researcher was a raised surface (e.g., table, box, etc.) where items could be placed. Due to the timing of the data collection, some children participated in the task while adults were masked. Each child completed the word-learning task in both Spanish and English, with the order counterbalanced. Children participated in 4 trials in each block. On each trial, children heard 2 novel words (1 target word and 1 foil) and were shown an associated target item and foil item by the researcher. To support attention, children were given time to look or touch an item placed on the raised surface while hearing the associated label in context several times (e.g., "Look at the "mehpay" /mɛpeɪ/") before being given time to look at, touch, and hear the appropriate label for the other item in context several times. On each trial, children had two chances to map the correct label to the trained item and two chances to extend the novel label to a different exemplar of the trained item (that differed in color only). Thus, in total, children heard 8 novel labels paired with 8 unfamiliar objects during the task.

In the Spanish block, novel labels followed Spanish phonological features and were presented in Spanish linguistic frames. Likewise, the English novel labels were followed English phonotactics and were presented in English linguistic frames. For example, in the Spanish condition, researchers would introduce the child to the items in Spanish and label the items with nonsense words conforming to Spanish phonotactic rules (e.g., "mepe" /mɛpɛ/). Mirroring this, in the English condition, researchers would introduce the child to an item in English and then label the items with nonce words conforming to English phonotactic structure (e.g., "mehpay" /mɛpeɪ/). The novel labels were "equivalent" in each language, distinguished only by the pronunciation/linguistic features of each language. Children only heard the words in one language (not both) because there were 4 different versions of this task that counterbalanced the words by language and participant (e.g., /mɛpɛ/ and /mɛpeɪ/, /timu/ and /timu/, /nika/ and /nika/, /bupo/ and /bupoʊ/.

Language Environment Recordings

Daylong LENA audio recordings (~12 to 16 hours/day) were collected on two consecutive days (typically a weekend) when both primary caregivers (i.e., mother and father for the current dataset) were home. LENA devices were placed into a small pocket on the child's clothing. After completing this portion of the experiment, participants were instructed to mail the device back in a prepaid envelope.

Data Collection & Coding Procedure

Data for this study was collected in-person and via LENA audio recordings. The research team visited the participant and their caregiver at their home to collect demographic data, standardized measures, and conduct the experimental word-learning task. Study visits typically lasted 90 minutes.

Data Processing & Coding

LENA data processing was conducted through multiple programs. Raw data from the devices (.WAV files) was initially uploaded to the LENA website and then downloaded to laboratory computers. Audio files were further processed using the LENA Advanced Data Extractor Tool (ADEX) to identify intervals of interest (i.e., those including high adult word count) and eliminate intervals that did not contain social or linguistic interaction (e.g., during the child's nap time) (ADEX; LENA, 2011). The ADEX tool was also used to segment each participant's two daily recordings into 30 second intervals and to automatically calculate adult word count for each interval.

Following segmentation, 30-second intervals were selected for data analysis. For each participant, 50 intervals per day were selected using a Python script (https://github.com/LDPlab/50-snippets-random), yielding a total of 100 intervals per participant. These 100 intervals were selected based on LENA's automated Adult Word Count (AWC) values; the highest 100 were chosen for analysis, assuming adult-child interaction would be high during these periods. At least 120 seconds elapsed between chosen intervals. The first author, a graduate student, identified and coded whether there was the presence of code-switching in mother's speech, father's speech, and target child's speech.

Several rules were established to unify coding efforts. Language produced during phone calls or video calls (e.g., Skype) was included in the definition of CS for this study. Conversely, language produced from toys/games (e.g., toys that talk if you push buttons) were not considered for this study. Accent and context were considered to determine whether words shared between languages like "no" or near-universal exclamations like "wow" would be counted as CS. Furthermore, "OK" or "okay" was always considered an English borrowing and never considered as CS. If someone produced a mixture of babbling/unintelligible speech and distinguishable language, the distinguishable language would take precedent for coding purposes. Babbling/unintelligible speech was coded separately from language which could be distinguished as English or Spanish; it was inclusive of sounds like mm-hm which aren't necessarily words but have a distinguishable purpose in showing confirmation or agreement. Likewise, pure vocalizations that did not suggest syllable shapes were coded as no language rather than as babbling/unintelligible (e.g., crying, playing with pitches).

Coding was initially binary (e.g., 0 = no code-switching and 1 = presence of code-switching). We identified the number of intervals (out of the 100) in which CS occurred at least once within the 30-second interval. However, additional coding was implemented so that target child, mother, and father were also coded for both their CS and specific language production. Target child was coded for CS (e.g., 0 = no code-switching, 1 = code-switching, 2 = no language) and specific language (e.g., 0 = no language, 1 = English, 2 = Spanish, 3 = both/code-switching, 4 = babbling/unintelligible). Mothers and fathers were coded for CS under one variable (e.g., 0 = no code-switching, 1 = mother code-switching; 2 = father code-switching; 3 = both parents code-switching). Mothers and fathers were separately coded for their specific language use (e.g., 0 = no language; 1 = English; 2 = Spanish; 3 = both/code-switching). Due to the nature of this analysis method, detailed transcription was not necessary, and the author was not fluent in Spanish. About twenty percent of initial coding (n = 5) was double-coded for inter-rater reliability by the last author, a fluent Spanish speaker. Percent agreement for overall CS occurrence per subject was 93.2%, child CS was 93.8%, and parents' CS was 93.4%. Due to the high reliability, the first author's codes were used during all analyses. Discrepancies were discussed to ensure consistency between coders. It should be noted that a separate binary variable was created to code whether CS occurred in media (e.g., an TV host switching from Spanish to English) and other people who may be interacting with the child (e.g., friends, siblings) during the interval. This was the only variable that included the language/CS of speakers beyond the target child, mother, and father.

Word Learning Task Coding

The researchers coded video-recordings of the word learning task, to evaluate whether the child identified the target item. After the child was prompted for the target item, the “first touch”, or the first item that the child touched, was coded as the child’s response. Research assistants identified the correct version (e.g., 1-4) and language order (e.g., 1: English, Spanish, 2: Spanish, English) that each participant was presented. They then coded the 16 different trials (e.g., 0: wrong (foil); 1: correct (target); 2: no response; 3: invalid trial). If the child correctly touched the target item, then they would be scored a 1/1, for a potential total of 16/16 after running all conditions (8/8 for each language). RAs only scored a trial as “invalid” in rare cases where it was not administered at all for extraneous reasons.

Planned Analyses:

The first research question addresses the frequency of CS in both child’s use and caregiver input. The frequency of child CS was summed, and a proportion was generated to determine the number of code-switched intervals out of 100 coded intervals that included at least one instance of CS (e.g., code_switch_child/100). To evaluate caregiver CS, we used the same procedure to calculate the overall proportion of code-switched intervals produced by both caregivers. To determine whether there were differences by parent, we subsequently calculated separate proportions for each caregiver. In our sample, this included the mother and the father. Thus, the frequency of CS was summed for each parent, and a proportion was generated to determine the proportion of code-switched intervals out of 100 coded intervals (e.g., code_switch_parent(1)/100, code_switch_parent(2)/100). Using the proportions generated from the first research question, the second research question addressed whether both parent and child CS frequency correlate with toddlers' overall vocabulary development. Each of the values were correlated with M-CDI raw vocabulary scores (e.g., English, Spanish, and Total/Combined). Research question three focused on the correlation between the frequency of CS and toddlers' word-learning. Both parent and child CS proportions from the first research question were correlated to word learning skill totals ($0 \leq x \geq 16$) in both English and Spanish. These values were statistically correlated to the toy task word learning data.

Expected Outcomes:

1. For research question 1, we expected to identify CS in parent input and in child use. We also predicted high variability in proportion of CS across participants. We anticipated child CS to have significant correlations to caregivers.
2. For research question 2, we expected to identify correlations between CS in both parent input and child use and vocabulary as measured by raw M-CDI scores in English, Spanish, and combined total vocabulary.
3. For research question 3, we expected to identify correlations between CS in both parent input and child use and word learning in both English and Spanish.

Results

Question 1: CS Frequencies

Descriptive data for language and CS values are presented in Table 2 and Figure 1. Children produced an average of 6.91 intervals with CS, 30.48 English-only intervals, 12.65

Spanish-only intervals, and an overall average of 67.30 intervals with intelligible spoken language. Children had a significantly higher number of English-only intervals relative to Spanish-only intervals ($p < .001$). Mothers produced an average of 19.30 intervals with CS, 25.36 English-only intervals, 26.43 Spanish-only intervals, and an overall average of 72.70 intervals with intelligible spoken language. Mothers did not have a significant difference in English-only vs Spanish-only intervals ($p = .858$). Fathers produced an average of 7.57 intervals with CS, 23.65 English-only intervals, 12.52 Spanish-only intervals, and 42.22 intervals with intelligible spoken language. The fathers had a near-significantly higher average amount of English-only intervals relative to Spanish-only intervals ($p = .060$). Fathers had a significantly less intervals with intelligible spoken language relative to mothers ($p < .001$).

Out of 100 intervals, the mean number of occurrences of CS across all sources was 33.04 (SD = 18.30). Children had a mean CS frequency of 6.91 (*SD* = 8.38, range = 0-30). Parents had a combined mean CS frequency of 28.17 (*SD* = 17.60, range = 0-65). When reported separately, mothers had a mean CS frequency of 19.30 (*SD* = 13.98, range = 0-54) and fathers had a mean CS frequency of 7.57 (*SD* = 10.47, range = 0-41). Inter-rater reliability was calculated by computing the percent agreement (e.g., the total number of intervals with agreement divided by the total number of intervals).

Most participants did not produce language in every interval. Thus, these overall CS frequencies were adjusted by dividing the total number of CS instances by the number of intervals that had any language from the target person (e.g., total number of intervals with child CS / total number of intervals with child language produced). In doing so, the overall frequencies increased relative to their unadjusted counterparts, though t-tests were not significant (*p*s > .05) and suggested no significant difference between the total CS vs. Adjusted CS frequencies were as follows: child (*M* = 9.19, *SD* = 9.93, range = 0-39); parents (*M* = 31.6, *SD* = 18.75, range = 0-70); mother (*M* = 25.40, *SD* = 16.00, range = range = 0-59); and father (*M* = 13.21, *SD* = 15.14, range = 0-55). This data is presented in Figure 1. While there was no statistical difference between the raw vs. adjusted frequencies, this study utilized adjusted values to better account for the relative amount of CS produced within each person's relative language output as fathers had significantly lower amounts of language produced within the 100 intervals ($p < .001$).

Child CS frequencies were then correlated with mother, father, and parent CS frequencies using simple Pearson correlations. This data is presented in Figure 3. Adjusted child CS frequency was not significantly correlated to adjusted mother CS frequency ($p = .112$). Conversely, adjusted child CS frequency was significantly correlated to adjusted father CS frequency ($p = .002$). Finally, adjusted child CS frequency was significantly correlated to adjusted combined parent CS frequency ($p = .005$).

Question 2: CS frequencies predicting child vocabulary

To examine whether CS frequencies predicted children's productive vocabulary, three multiple linear regression models were generated: one predicting child vocabulary in English, one predicting child vocabulary in Spanish, and one predicting combined English and Spanish child vocabulary. Age, English LEAT scores, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were used to predict children's raw English M-CDI scores. English LEAT ($p < .001$), adjusted child CS frequency ($p = .003$), and adjusted mother CS frequency ($p = .037$) were all significant predictors for raw English M-CDI vocabulary ($R^2 = .754$). Notably, adjusted mother CS frequency was negatively correlated with raw English M-CDI vocabulary, meaning that increased frequency of mother CS suggested decreased English vocabulary. Age, Spanish LEAT scores, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were used to predict children's raw Spanish M-CDI scores. Adjusted child CS frequency was a significant predictor of raw Spanish M-CDI vocabulary (p = .004, R^2 = .7364). Neither mother nor father CS frequency were significant predictors of children's Spanish productive vocabulary within this multiple regression equation. Age, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were used to predict children's combined raw English and Spanish M-CDI scores. Adjusted child CS frequency was a significant predictor of combined raw English and Spanish M-CDI scores (p = .005, R^2 = .682). Individual's CS frequencies as a function of M-CDI scores are presented in Figure 5.

Question 3: CS frequencies predicting child word-learning

To examine whether CS predicted children's word learning skills, three multiple linear regression models were generated: one predicting child word learning in English, one predicting child word learning in Spanish, and one predicting combined English and Spanish child word learning. Age, English LEAT scores, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were entered as independent variables to predict children's English word learning scores. Adjusted child CS frequency (p = .034) was a significant predictor for English word learning (R^2 = .4297), though age in months and English LEAT scores were not. Age, Spanish LEAT scores, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were used to predict children's Spanish word learning scores. No variables were significant predictors of raw Spanish word learning scores (R^2 = .182). Age, English LEAT scores, adjusted child CS frequency, adjusted mother CS frequency, and adjusted father CS frequency were used to predict children's combined raw English and Spanish word learning scores. No variables were significant predictors of combined raw English and Spanish word learning scores (R^2 = .256). Individual's CS frequencies as a function of word learning scores are presented in Figure 5.

Exploratory Analysis

Two significant findings guided the exploratory analyses for this study. The first was the significant positive correlation between adjusted father CS frequency and adjusted child CS frequency in contrast to the positive but non-significant correlation between adjusted mother CS frequency and adjusted child CS frequency in research question one. Within our sample, mothers tended to produce more intervals with CS. There is also some research that suggests that the possible benefits of CS may be more evident in children older than 5-years-old (Kaushanskaya & Crespo, 2019; Kaushanskaya et al., 2023; Kremin et al., 2021; Sun et al., 2020). Hence, a linear model correlating both child age in months and adjusted mother CS frequency were used to predict adjusted child CS frequency. While this new model still produced a nonsignificant result (p = .078), it was closer to significance in contrast to the simple Pearson model. The second finding was the significant negative correlation between adjusted mother CS frequency to raw English M-CDI vocabulary in the multiple regression within research question 2. Mothers had significantly higher mean raw Spanish output relative to fathers; in this study, raw Spanish output meant number of intervals where an individual only spoke Spanish. Hence, a Pearson's correlation between mothers' Spanish-only output and child raw Spanish M-CDI vocabulary while controlling for child age in months and Spanish LEAT scores was computed; this was not significant (p = 0.397). Within this sample, mothers also had significantly more intervals with language relative to fathers as well as higher adjusted CS frequency relative to fathers (p = .011). Finally, recalculating results with raw CS frequencies rather than adjusted CS frequencies did not influence the significance of planned or post-hoc analyses.

Discussion

Question 1: CS Frequencies and Associations

CS occurred in nearly all participants (e.g., 22 of the 23 children within natural contexts by all communication partners, though children did not code-switch more often than their parents in contrast to what was initially suggested by Meng & Miyamoto (2012), Mishina (1999), and Mishina-Mori (2011). However, these studies featured bilingual language combinations that were not Spanish-English, which may have different implications for outcomes. Additionally, the definition of "frequency" for this study was not a true frequency count (e.g., counting every number of CS / total utterances) and may have impacted our results; our definition of CS frequency was the overall number of intervals with CS / number of intervals. Overall, CS occurred an average 33.04 times across 100 30-second intervals; nearly 1 out of 3 involved code-switching. If we had used a true frequency count (e.g., continuous event sampling) that identified each instance of code-switching within the 100 intervals, our averages would likely be even higher. Mothers seemed to code-switch most frequently at an average of 19.30 intervals per 100 intervals, whereas fathers and children had less at 7.57 and 6.91 respectively. However, as expected for diverse bilingual family language backgrounds, there was substantial variability in the amount of code switching; adjusted CS ranged from 0-39 for target children, 0-59 for mothers, 0-55 for fathers, and 0-70 for parents. T-tests suggested that there were no significant differences in overall frequency of CS when excluding for periods of silence, adjusted CS frequencies (*ps* = .149 to .406). This suggests that in naturalistic contexts with relatively larger sample sizes, CS may be more likely to occur than may have been indicated via prior smaller-sample or case-study populations.

When comparing the correlations between adjusted child CS with adjusted mother CS and father CS, only father's instances of CS appeared to have a significant positive association with adjusted child CS. Since adjusted mother CS did not have a significant correlation to adjusted child CS, the significant correlation between adjusted combined parent CS and adjusted child CS appears to be driven by father CS. Several factors could be at play to explain this phenomenon. At 2- to 3-years-old, children are likely producing shorter utterances relative to adults and the selection of intervals based on adult word count may be skewing the relative proportion of CS and/or each language's use. Secondary analyses revealed that linear models that used both child age in months and adjusted mother CS frequency to predict adjusted child CS frequency had a positive correlation that was not significant, but closer to significance ($p = .078$). Perhaps this specific age influences the lack of correlation found between mother CS and child CS. It is possible that selecting intervals based on different parameters, for example high conversational turn counts, may provide additional instances of parent and child CS within episodes of engagement.

It is also worth noting that the function of CS was not investigated; perhaps there are certain types of caregiver CS that are more correlated to child CS. Alternatively, there may be external language sources that influence children; many intervals featured media language or language from other people in the child's home. There is evidence to suggest that language heard from others, such as grandparents and siblings can influence the language of target children (Bridges & Hoff, 2014; Ishizawa, 2004); Ishizawa (2004) highlighted the increased heritage language capacity of children hearing their heritage language from their grandparents while Bridges and Hoff (2014) noted that increased English exposure from older siblings increased English skills among target children. Likewise, it appears that language transmitted through media can also impact the language of children, typically in the context of regular exposure to the societal “majority” language (Kuppens, 2010; Moring et al., 2011; Peters, 2018). Finally, some research suggests that fathers, though producing significantly less language around their children, may have a different but nonetheless equally important impact on children’s language (Ferjan Ramírez et al., 2022; Shapiro et al., 2021). The current research is consistent with these findings, suggesting that fathers’ language mixing plays a significant role in the development of children’s own use of language.

Question 2: CS frequencies predicting child vocabulary

M-CDI Scores were presented in Figure 2. Significant correlations between CS frequencies and children’s own vocabulary were identified in analyses, generally suggesting that higher adjusted child CS frequencies were indicative of higher vocabulary skills and that there were positive benefits to children’s own production of CS. For English vocabulary, English LEAT scores and adjusted child CS frequency were positively, significantly correlated to children’s raw English M-CDI vocabulary scores while adjusted mother CS frequency was negatively, significantly correlated to children’s raw English M-CDI vocabulary scores. Adjusted child CS frequency also significantly correlated to raw Spanish M-CDI vocabulary. Finally, adjusted child CS frequency significantly correlated to children’s combined raw English and Spanish M-CDI scores. Scatterplots of results were presented in Figure 4.

Results suggested that the relative proportion of children's exposure to English (based on LEAT scores) was significantly associated with children's English productive vocabulary. These findings are consistent with a large body of evidence indicating that language input is a significant predictor for children's vocabulary development (Hammer et al., 2012; Hurtado et al., 2014). A novel finding from this study is that children's own use of CS is also correlated with

English vocabulary development. This suggests that a child's own CS production is important to consider and may be indicative of a positive mechanism that supports language development. For instance, prior literature has explored that CS may reflect cognitive control or flexibility in adults (Declerck et al., 2019; Kharkhurin & Wei, 2015; Yim & Bialystok, 2012). The literature on CS's relationship to cognitive control and flexibility is more mixed for children (Kuzyk et al., 2020; Poulin-Dubois et al., 2011; Sun et al., 2020). Since the current study did not explicitly test aspects of children's cognitive control or executive functioning, future research on the mechanisms underlying the positive association between children's CS and their vocabulary skills is warranted.

An unexpected finding was that higher levels of adjusted mother CS frequency negatively correlated to children's English vocabulary. It is worth noting that there are inherent elements of the study's design that may influence this. Caregiver-reported measures like the LEAT and M-CDIs are imperfect though useful tools, and it is possible that they may not accurately portray the child's true vocabulary. When considering the M-CDIs, it is also essential to note that they are normed monolingually (e.g., one English version and one Spanish version) rather than bilingually, which may impact the validity of results. Moreover, the function of CS was not considered though it may influence the language that children produce. Certain studies suggest that there is a high percentage of CS that primarily consists of directly translating vocabulary and/or that parents will be intentional in their use of CS to teach vocabulary (Byers-Heinlein, 2013; Kremin et al., 2022; Mishina-Mori, 2011). Perhaps mothers use CS in different ways from fathers. This is an important direction for future research.

Interestingly, increased Spanish exposure did not appear to significantly correlate with Spanish vocabulary or combined English and Spanish vocabulary in contrast to prior literature

(Hammer et al., 2012; Hurtado et al., 2014)). Once again, it is possible that the caregiver-reported measures (e.g., LEAT, M-CDI) are not a perfect reflection of the home environment, and this analysis was reliant on their accuracy. Within the regression model, adjusted child CS frequency was the only variable significantly correlated to raw Spanish M-CDI vocabulary scores ($p < .001$) or combined raw English and Spanish M-CDI vocabulary scores ($p = .005$). Paralleling English results, another novel finding from this study is that children's own use of CS is also correlated with Spanish vocabulary development as well as overall combined English and Spanish vocabulary. This suggests that an increase in a child's own CS production does not negatively impact either of their languages and supports the idea that CS is indicative of cognitive control and flexibility.

Question 3: CS frequencies predicting child word-learning

Findings for whether CS frequencies significantly correlated with child word-learning were language specific. Adjusted child CS frequency was a significant predictor for English word learning ($p = .034$, $R^2 = .430$), though age in months and English LEAT scores were not. Once again, adjusted child CS frequency appears to be a significant predictor of child language development. Prior literature (Byers-Heinlein, 2013, 2022; Guevara, 2020) has suggested that CS can be more neutral-negative for children under 5-years-old with certain methodologies, making this significant correlation between adjusted child CS frequency and English word learning even more noteworthy. Within our descriptive data of naturalistic language, fathers spoke more English than Spanish, and mothers spoke roughly equivalent amounts of Spanish and English. In addition to this, children had significantly higher English production relative to Spanish in naturalistic language recordings ($p < .001$), even though their caregiver-reported M-CDI vocabulary scores were not significantly different between languages ($p = .329$). Perhaps the sample's relatively higher amount of expressive English language production in naturalistic language contexts suggests an increased familiarity with English for the children. As aforementioned, the function of CS within these intervals was not specifically investigated for this thesis. It is possible that learning English as part of the societal majority language lends itself towards it being explicitly taught in direct teaching contexts (e.g., using CS to teach the English word for a word in Spanish). Prior literature supports the idea that CS is often used to teach a word in the other language, whether it's explicit teaching or repeating something again in the other language (Byers-Heinlein, 2013; Kremin et al., 2022; Mishina-Mori, 2011; Sun et al., 2020).

Conversely, no variables were significant predictors of Spanish word learning or combined English and Spanish word learning. Given the children's and fathers' higher English production, this may parallel Potter et. al (2019) who found additional CS switching costs when learning words in the non-dominant language. Similarly, for this thesis, children learned words in a monolingual context (e.g., all in Spanish or all in English) that may have naturally resulted in scores being lower. Even if the raw scores were combined for a total English and Spanish word learning score, it may be difficult to account for the natural way that bilingual children learn new words. Unlike measures like the LEAT or M-CDI, this measure was administrated by researchers. While conducted in the home, it is difficult to gauge whether the classic fast-mapping paradigm or the determination of first touch as a child's answer is the best or most natural way to judge word learning in isolation.

Conclusions

This research aimed to identify the frequency of CS in bilingual Spanish-English 23- to 36-month-old toddlers and caregivers and whether the CS was correlated to the language development measures of vocabulary and word learning. Overall, CS occurred in most children's naturalistic conversations, and children's own use of CS appeared to be important for their own language development. Alternatively, given the method of analysis, it is equally plausible that higher language skills (e.g., vocabulary, word learning) may lead to higher CS; the directionality and causality cannot be concluded based on these findings. Nonetheless, CS may be an incredibly important indicator for the strong linguistic prowess of bilingual children in this early toddler age. It is also important to acknowledge the large variability present in the sample. Participants had variation in their language skills, different levels of language input within two-parent households, and a range of social and linguistic experiences.

Future research is necessary to explore the implications of these findings. A larger sample would be preferable to increase the power of these findings and explore generalizability, especially if it encompassed participants from various geographic areas or differing language combinations. Different language combinations have different linguistic features and may introduce different sociocultural factors that may result in different CS patterns and consequent correlations to child language development measures. Since age did not appear to have a significant role in the present study, longitudinal studies may also offer a better insight into how CS patterns and potential correlations to child language development may change over time, as individual variability may be impacting the results of the present study. Furthermore, future research should try to distinguish the influence of individual caregivers and other language sources such as media or other people (e.g., siblings, grandparents, family friends, etc.). Additional research could investigate whether results varied when analyzing the CS and language development of children with DLD or other communication disorders to expand potential clinical applications.

Based on these results, there are some methodological implications for future research on CS. Those who are evaluating a bilingual child's language for CS may not need to be fully fluent in both languages of the bilingual child, so long as they are fluent enough in one of the languages to comfortably distinguish between the two languages. Caregiver-reported measures are reliable and essential to offer more detailed information about a child's language and language exposure (e.g., language exposure, vocabulary), especially in circumstances where evaluators are not bilingual and/or fluent in the languages of a specific child. Overall, the use of increased CS among bilingual toddlers does not indicate linguistic confusion, but rather, highlights their linguistic mastery.

Table 1

Study Demographics

	Mean	Standard Deviation	Frequency
Age in months	28.00	4.34	N/A
Assigned female at birth	N/A	N/A	14
Assigned male at birth	N/A	N/A	9
LEAT English scores	0.41	0.20	N/A
LEAT Spanish scores	0.59	0.20	N/A
SES score (8-66)	43.57	11.31	N/A
Current SLP services	N/A	N/A	2
Parent concerns (Spanish)	N/A	N/A	6
Parent concerns (English)	N/A	N/A	3

N = 23 children.

Table 2
Language Produced in LENA Audio Recordings

Statistic	Total CS	Child CS	Mother CS	Father CS	Child Eng.	Mother Eng.	Father Eng.	Child Spa.	Mother Spa.	Father Spa.	Child Speak	Mother Speak	Father Speak
Mean	33.04	6.91	19.30	7.57	30.48	25.36	23.65	12.65	26.43	12.52	67.30	72.70	42.22
Standard Deviation	18.30	8.38	13.98	10.46	19.24	22.36	24.08	12.18	20.22	13.04	19.34	15.56	23.00

Key: Child Eng. = Child English, Mother Eng. = Mother English, Father Eng. = Father English, Child Spa. = Child Spanish, Mother Spa. = Mother Spanish, Father Spa. = Father Spanish, Child Speak = Child intervals with spoken language, Mother Speak = Mother intervals with spoken language, Father Speak = Father intervals with spoken language

Table 3

Child Language Assessment Scores

Statistic	M-CDI English	M-CDI Spanish	M-CDI total	Word learning (English)	Word learning (Spanish)	Word learning (Total)	PLS total
Mean	188.30	142.39	330.70	4.78	4.17	8.96	102.47
Standard Deviation	173.72	139.95	265.42	2.43	2.46	4.44	15.34

Figure 1

Language Produced in LENA Audio Recordings

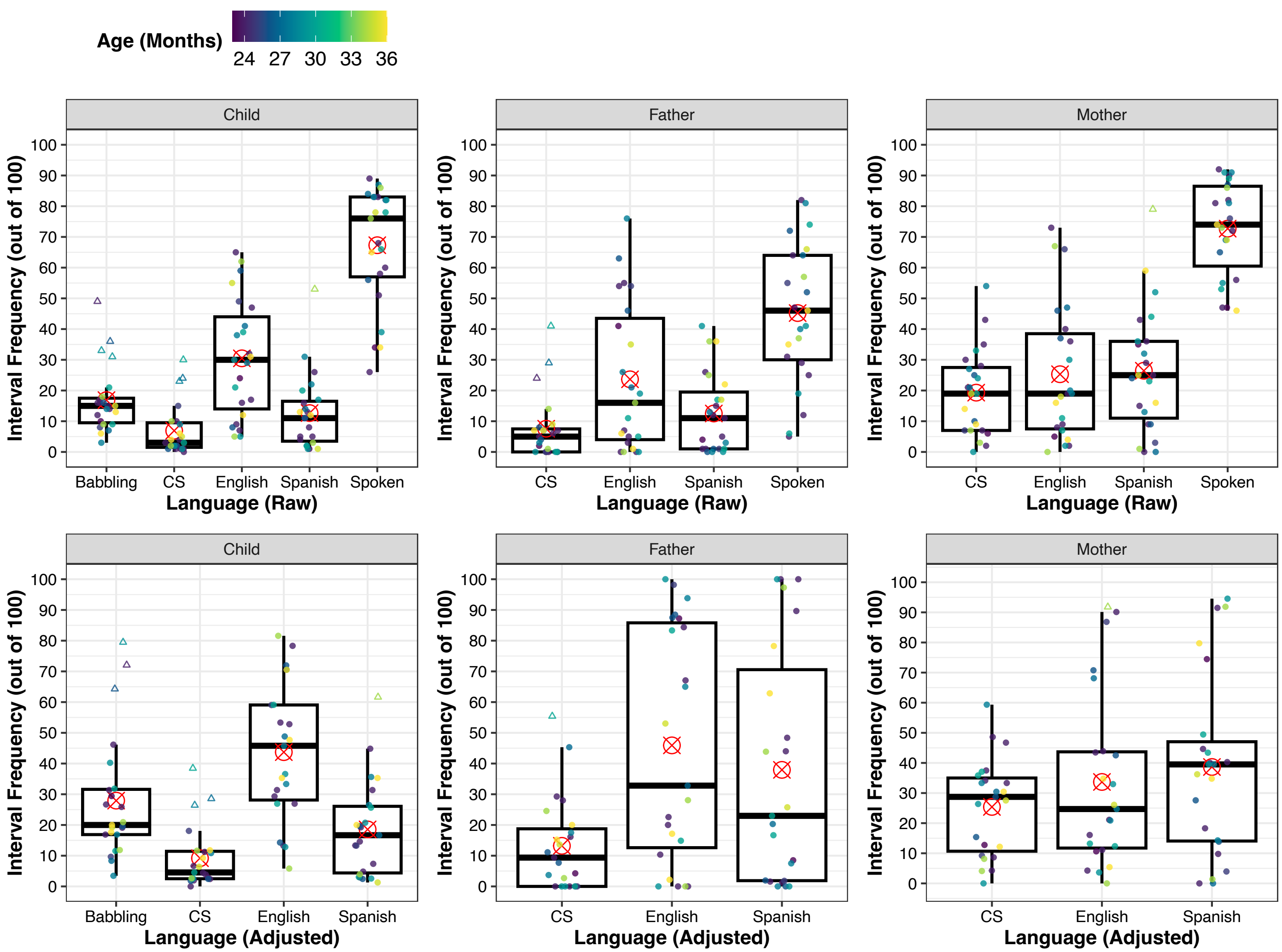
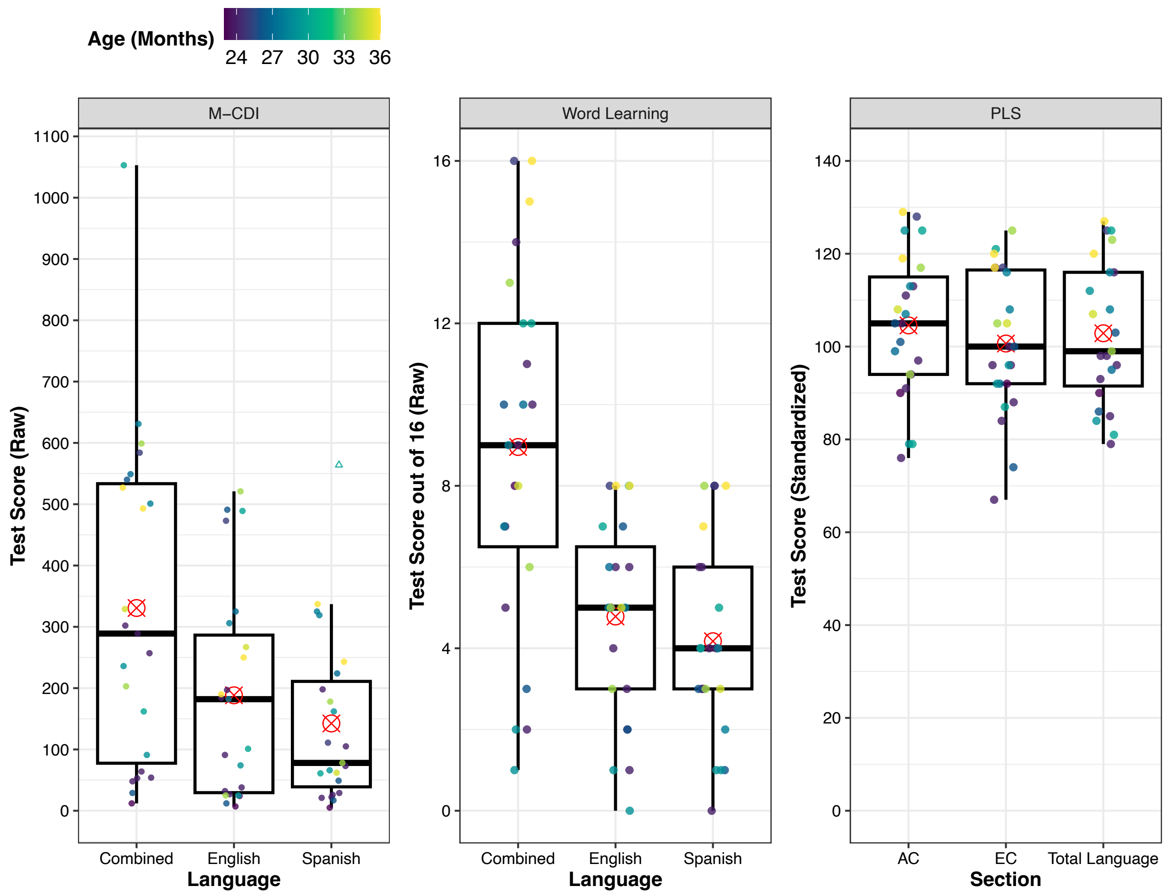


Figure 2

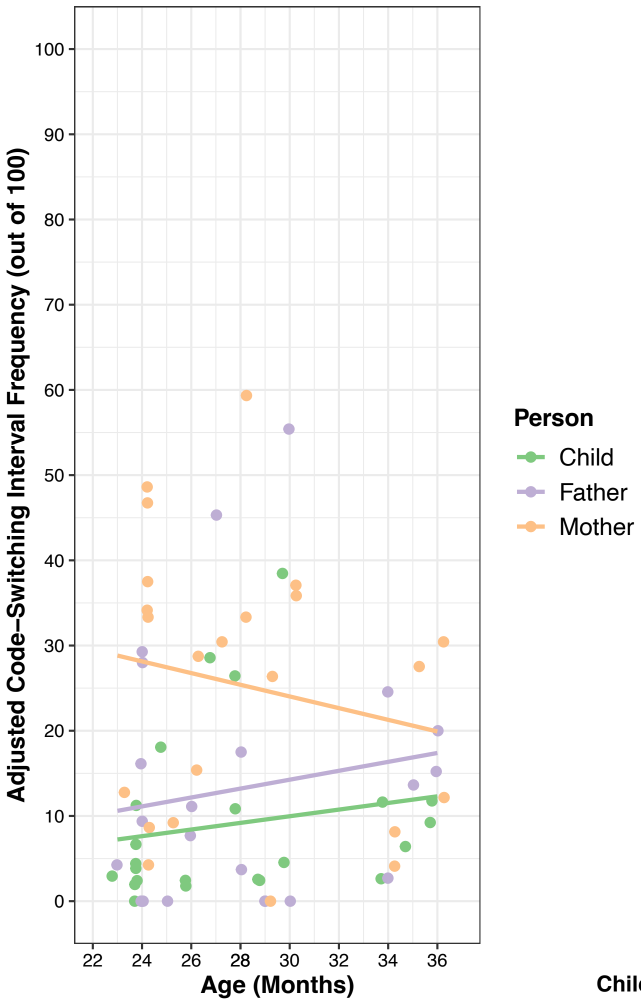
Child Language Assessment Scores



Key: AC = Auditory Comprehension; EC = Expressive Communication

Figure 3

Adjusted Code-Switching Frequencies as a Function of Age & Adjusted Parental Code-Switching Frequencies as a Function of Child Code-Switching Frequencies



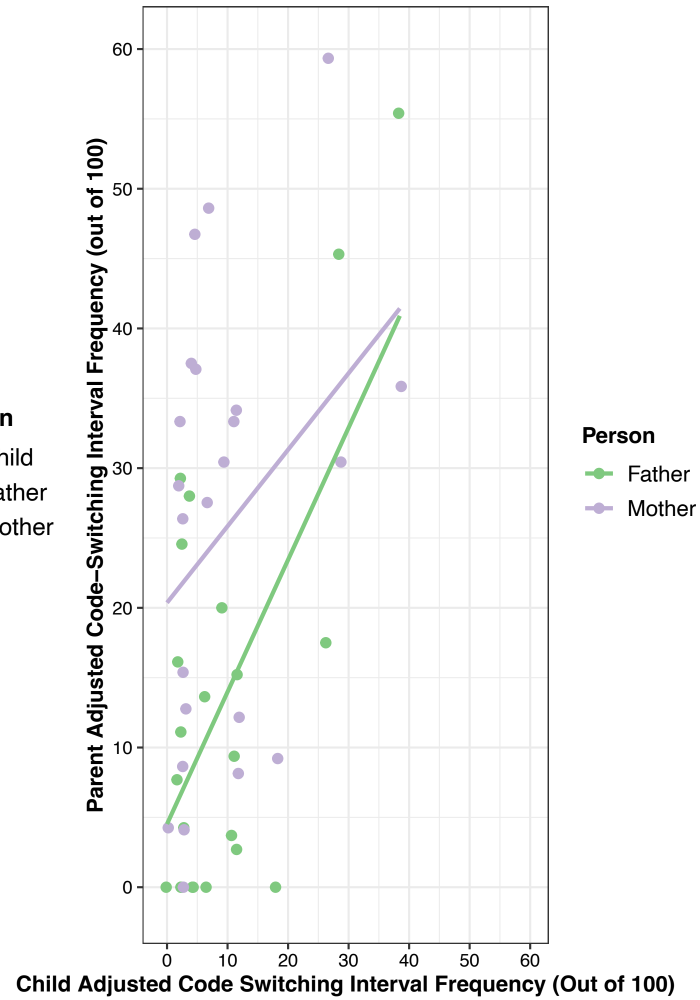


Figure 4

Adjusted Code-Switching Frequencies Per Person as a Function of Child M-CDI Scores

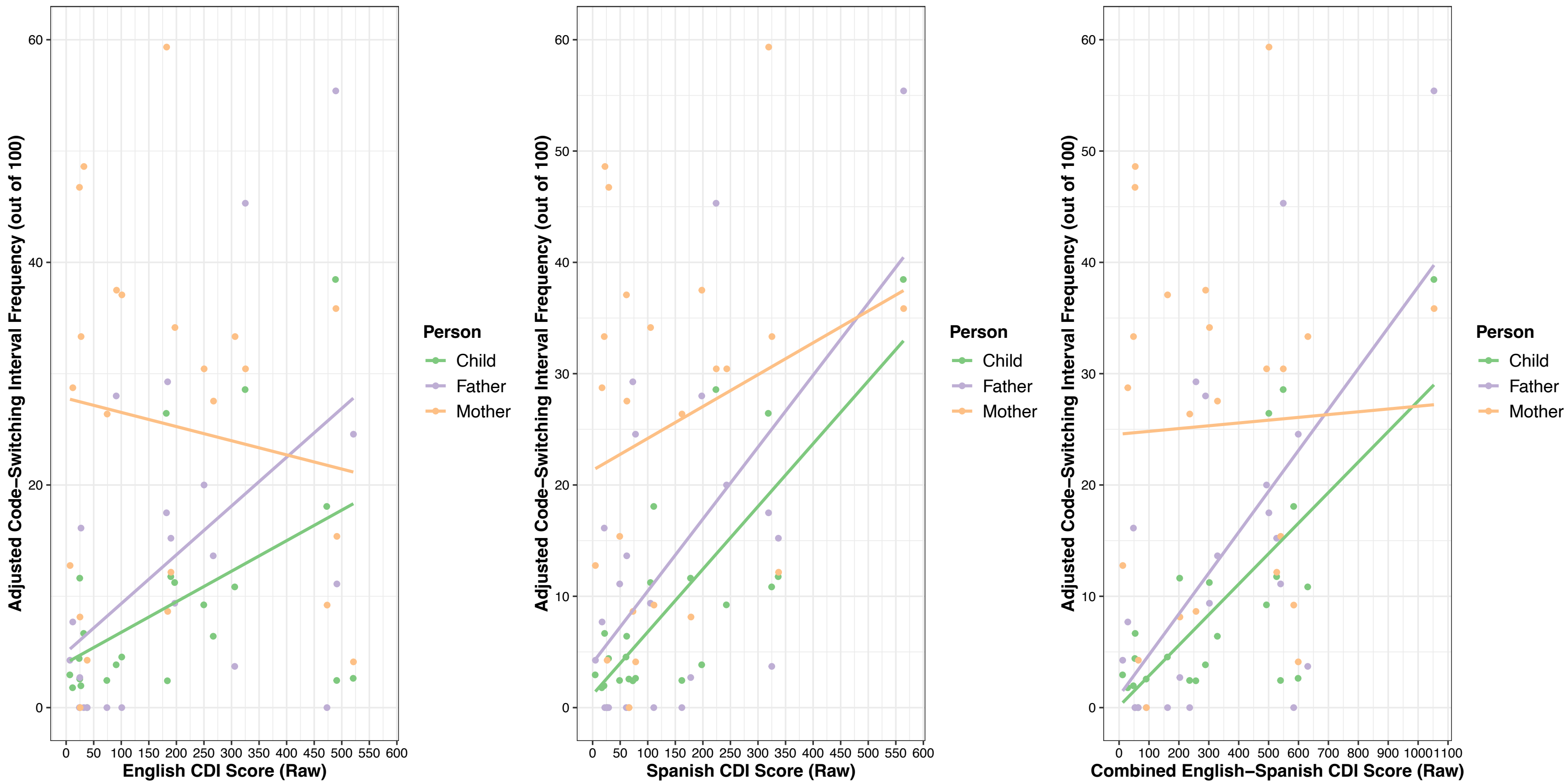
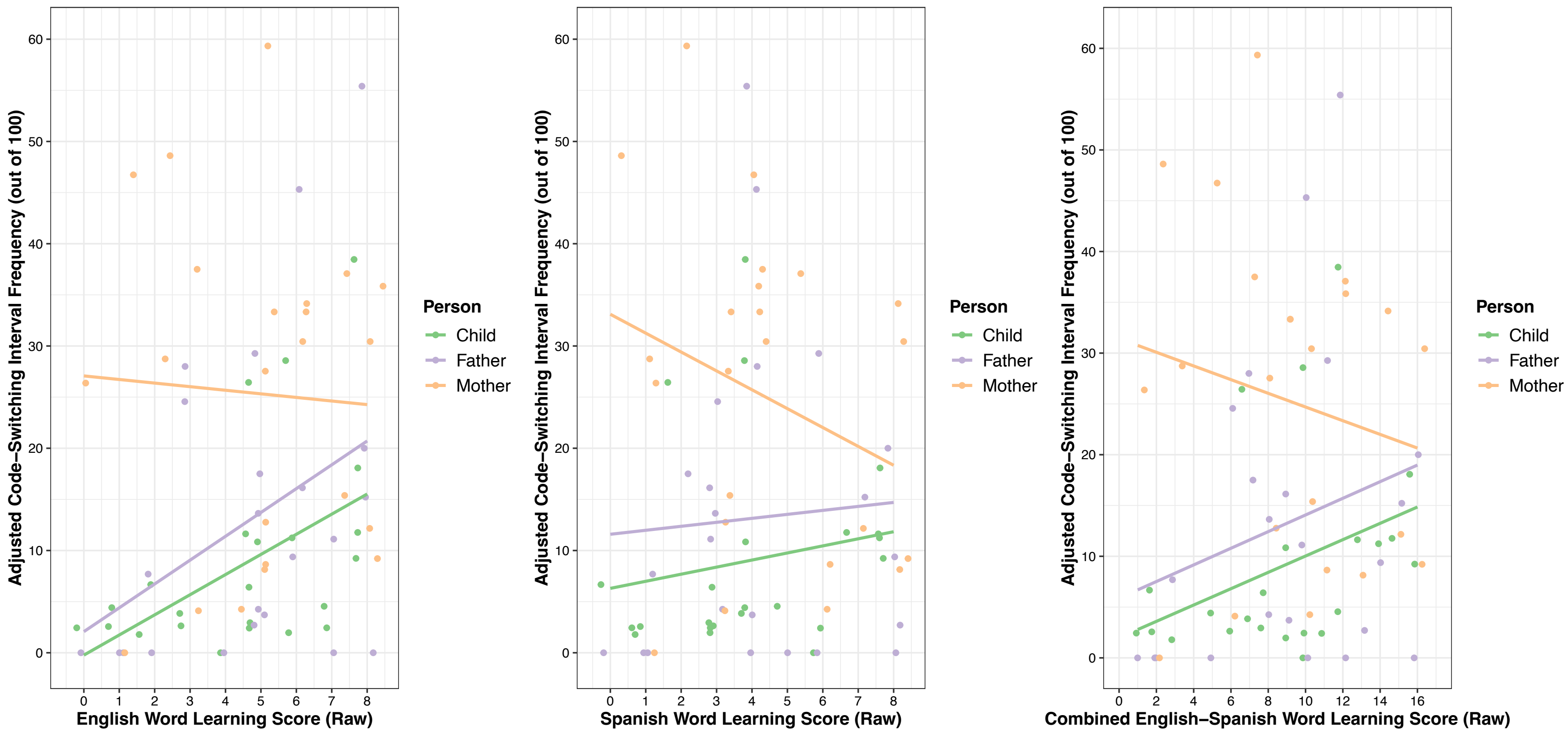


Figure 5

Adjusted Code-Switching Frequencies Per Person as a Function of Child Word-Learning Scores



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